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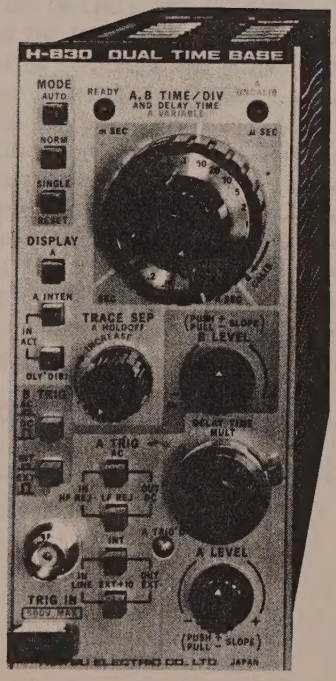
IWATSU
Dual Time Base Unit
H-830



INSTRUCTION MANUAL

DUAL TIME BASE UNIT

H-830

D1339-616500 (L)

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Section 1 Specifications

The H-830 is a dual time base unit to compose the 8000 series system. It allows ordinary sweep display as well as the magnified observation by the delay sweep and alternate sweep.

1-1 ELECTRICAL CHARACTERISTICS

1-1-1 Triggering

A Trigger

Source	Internal, External (EXT, EXT÷10)
Coupling	AC, DC, LF REJ, HF REJ
Slope	Positive, Negative
Sensitivity	Shown in Table 1-1

Table 1-1-1 (10°C to 35°C)

Frequency range	Level	
	Internal (Display amplitude)	External (Input voltage)
DC to 10 MHz	0.3 div	100 mVp-p
10 MHz to 50 MHz	1.0 div	150 mVp-p
50 MHz to 100 MHz	1.5 div	150 mVp-p

<Notes>

1. The trigger signals attenuate in the following frequency range depending on the trigger couplings.
   AC: 30 Hz or less
   LF REJ: 10 kHz or less
   HF REJ: 10 kHz or more
2. In the AUTO position of the sweep MODE switch, the lower end of triggerable frequency is 50 Hz.
3. When -3 dB frequency range of the vertical deflection system is narrower than the frequency range shown in Table 1-1-1, it is applied as the triggering frequency range.

B Trigger

Source	Internal, External
Coupling	AC, DC
Slope	Positive, Negative
Sensitivity	Shown in Table 1-1-2

Table 1-1-2 (10°C to 35°C)

Frequency range	Level	
	Internal (Display amplitude)	External (Input voltage)
DC to 10 MHz	0.3 div	100 mVp-p
10 MHz to 50 MHz	1.0 div	150 mVp-p

<Notes>
1. Signals below 30 Hz are attenuated in the AC coupling.
2. When -3 dB frequency range of the vertical deflection system is narrower than the frequency range shown in Table 1-1-2, it is applied as the triggering frequency range.

External Input (Applied for A Triggering and B Triggering)

Input RC: 1 MΩ ±5% // 20 pF±10 pF
Maximum Input Voltage: 500 V (DC + Peak AC)

1-1-2 Sweep

Display Mode: A sweep, A intensified by B,
B sweep, Alternate sweep of A and B

A Sweep
Sweep mode: Automatic, Normal, Single
Sweep rate: 20 ns/div to 0.5 s/div in 23 calibrated steps in a 1-2-5 sequence.
20 ns/div to 1.25 s/div continuously variable with control.
Accuracy I: (Over center 8 divisions): ±2% (10°C to 35°C)
±4% (0°C to 50°C)
Accuracy II: (Over any 2 divisions within center 8 divisions):
±5% (0°C to 50°C)
Holdoff time: Continuously variable with control.

B Sweep
Sweep mode: Automatic, Triggered
Sweep time: 20 ns/div to 50 ms/div in 20 calibrated steps in a 1-2-5 sequence.
Accuracy I: (Over center 8 divisions): ±2% (10°C to 35°C)
±4% (0°C to 50°C)
Accuracy II: (Over any 2 divisions within center 8 divisions):
±5% (0°C to 50°C)
Delay time: 1 µs/div to 5 s
Accuracy: ±3% (10°C to 35°C)
Delay jitter: 1/20,000 or less
Sweep magnification:
10 times (Maximum sweep rate: 2 ns/div)
Magnified sweep rate accuracy I (Over center 8 divisions):
2 ns/div to 5 ns/div: ±4%
10 ns/div to 50 ms/div: ±3%
(10°C to 35°C)
Magnified sweep rate accuracy II (Over any 2 divisions within center 8 divisions):
2 ns/div to 5 ns/div: ±10%
10 ns/div to 50 ns/div: ± 6%
0.1 µs/div to 5 ms/div: ± 5%

1-1-3 Read Out Display

Display contents
Sweep rate setting value
A and A INTEN modes: A sweep rate setting value
DLY'D(B) mode: B sweep rate setting value
ALT mode: A and B sweep rate setting value
A sweep rate uncalibrating mark (>)

Display channel position	A sweep rate	
		Setting value: Odd number channels
	B sweep rate	
		Setting value: Even number channels

1-1-4 Signal Output

A Sawtooth	Sawtooth wave signal coincident with A sweep.	
	Output voltage:	Approximately 250 mV per unit time (Setting value of the A TIME/DIV switch)
	Base line:	Approximately 0 V
	Polarity:	Positive
	Output resistance:	Approximately 470 Ω
A Gate	Square wave signal coincident with A sweep.	
	Output voltage:	Approximately 1 Vp-p
	Base line:	Approximately 0 V
	Polarity:	Positive
	Output resistance:	Approximately 500 Ω
B Gate	Square wave signal coincident with B sweep.	
	Output voltage:	Approximately 1 Vp-p
	Base line:	Approximately 0 V
	Polarity:	Positive
	Output resistance:	Approximately 400 Ω

1-1-5 Power Consumption

Approximately 13 W
(Measured at primary circuit when installed to the SS-8120 Main Frame)

1-2 PHYSICAL CHARACTERISTICS

1-2-1 Weight

Approximately 1.4 kg

1-2-2 Dimensions

Exclusively used at 1 plug-in compartment of the Main Frame

MEMO

Section 2 Operating Information

2-1 INSTALLING TO MAIN FRAME

The H-830 unit can be installed to only the right plug-in compartment of the TS-8123 or the SS-8120 main frame. The accuracy of the sweep rate of this unit is ±3% (10°C to 35°C), but if the sweep rate is calibrated installing the H-830 to the Main Frame, it becomes ±2% (10°C to 35°C).

An ordinary oscilloscope is equipped with the H-830 unit in the right plug-in compartment and the V-810 unit in either or both of the left and center plug-in compartments of the Main Frame.

Handling Precautions

In handling the unit, keep your bare handles off from the rear plug of the unit, as it may be the cause of inferior insulation due to fats and dirts stuck to it. Try to keep it always clean with a piece of soft cloth moistened with ethyl alcohol.

Installing

Match the upper and lower rails with the rail guides of the Main Frame, insert the unit quietly until the plug on the rear of the unit touch the jacks of the Main Frame. Push the unit in by pressing the both sides of the front panel by hand, and the unit can be locked automatically with a sure installing.

Do not try to push the unmatched unit hard into the plug-in compartment.

Removing

Pull out the knob (PULL) located on the lower left side of the unit, and the unit can be taken out. There is a play in pulling out the knob, but the steady pull will unlock the unit to come out.

2-2 CONTROLS AND CONNECTORS

Refer to Figure 2-2-1 as to the locations of the controls and connectors.

MODE

Selects the following operating modes of A sweep.

AUTO: Free-running sweep is provided when the trigger signal is not applied or when the LEVEL control is adjusted beyond the triggering range.

NORM: Sweep stops when the trigger signal is not applied or when the LEVEL control is adjusted beyond the triggering range.

SINGLE: Single sweep mode. This button functions also as a RESET switch for the single sweep display.

DISPLAY

Selects the following display modes.

A: A sweep only is provided. The sweep rate is determined by the A TIME/DIV switch and A VARIABLE control.

A INTEN: A sweep intensified by B sweep is provided. This mode is used to select the magnified portion of the display in delay-sweep. The sweep rate is determined by the A TIME/DIV switch and A VARIABLE control, and the width of B sweep (B sweep rate) is set by the B TIME/DIV switch.

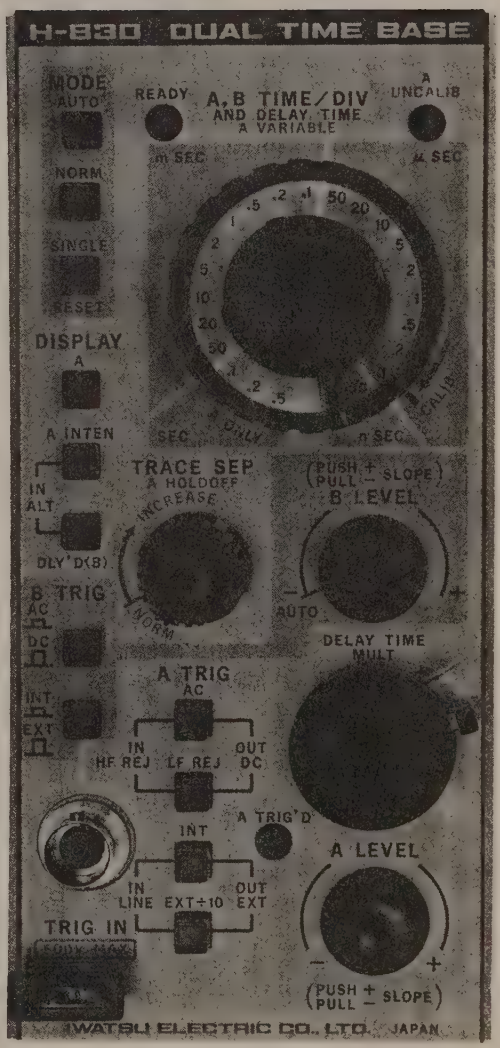
DLY'D(B): A portion intensified in the A INTEN mode is fully displayed on the CRT. The sweep rate is set by the B TIME/DIV switch.

ALT: The ALT mode is obtained when both of the A INTEN and DLY'D(B) buttons are pushed in. In this mode, alternate display of the A INTEN and DLY'D(B) sweeps is provided.

A, B TIME/DIV AND DELAY TIME

The A TIME/DIV AND DELAY TIME switch (outer black knob) selects the sweep rate of the A sweep and selects the basic delay time to be multiplied by setting the DELAY TIME MULT dial for delay-sweep operation. The A VARIABLE control must be set to the CALIB position for calibrated A sweep rate and calibrated delay time.

Figure 2-2-1. Front Panel



The B TIME/DIV switch (inner black knob) selects the sweep rate of the sweep for delay-sweep operation only.

A VARIABLE (Red knob)

Provides continuously variable sweep rates between the calibrated settings of the A TIME/DIV switch.

A UNCALIB

Light indicates that the A VARIABLE control is not in the CALIB position.

TRACE SEP

Controls the vertical position of the A INTEN sweep in the ALT sweep mode. Its variable width is 3 divisions or more.

A HOLDOFF

Provides controls of holdoff time between sweeps to obtain stable displays when triggering on a complicated pulse train such as complex digital words.

DELAY TIME MULT

This potentio-meter selects the amount of delay time between the start of A sweep and the start of B sweep.

— A TRIG —

AC-LF REJ-HF REJ-DC

Selects the following trigger signal couplings of A triggering. AC coupling is obtained by pushing the AC button in. LF REJ coupling is obtained by pushing the LF REJ button in. HF REJ and DC couplings are obtained by pushing both buttons of AC and LF REJ in and out respectively.

- AC: Rejects DC and attenuates signals below about 30 Hz. Signals above about 30 Hz pass.
- LF REJ: Attenuates signals below about 10 kHz. Signals above about 10 kHz pass.
- HF REJ: Attenuates signals above about 10 kHz. Signals below about 10 kHz pass.
- DC: Accepts all trigger signals from DC to 100 MHz or higher.

INT-EXT÷10-EXT-LINE

Selects source of trigger signal of A triggering. The internal triggering is obtained by pushing the INT button in. The external triggering, of which the external trigger signal is attenuated to 1/10, is obtained by pushing the EXT÷10 button in. The line triggering and external triggering are obtained by pushing both buttons of INT and EXT÷10 in and out respectively.

- INT: A sample of the input signal from the vertical unit is supplied as the trigger signal.
- EXT: External signal applied to the TRIG IN connector is used as the trigger signal.
- EXT÷10: Signal applied to the TRIG IN connector, after attenuated to 1/10, is supplied.
- LINE: Line frequency signal of the power circuit is supplied as the trigger signal.

A TRIG'D

Light indicates that the A sweep is precisely triggered.

A LEVEL

Controls the trigger level for A triggering. By pulling the knob of this control, the trigger level is set to the negative-going slope of the trigger signal. In its pushed state the trigger level is set to the positive-going slope.

TRIG IN

Input connector for the external trigger signals used both for the A triggering and the B triggering.

— B TRIG —

AC-DC

Selects the coupling modes of B triggering. Pushing the switch in and out allows the AC and DC couplings respectively.

- AC: Rejects DC and attenuates signals below about 30 Hz. Signals above about 30 Hz pass.
- DC: Accepts all trigger signals from DC to 50 MHz or higher.

INT-EXT

Selects source of trigger signal of B triggering. Pushing the switch in and out allows the INT (internal triggering) and EXT (external triggering) respectively.

INT: A sample of the input signal from the vertical unit is supplied as the trigger signal.
EXT: External signal applied to the TRIG IN connector is used as the trigger signal.

B LEVEL

Controls the trigger level for B triggering. Fully counterclockwise rotation of this control will initiate the automatic delay and clockwise rotation will provide the triggered delay and determine the trigger level. By pulling the knob of this control, the trigger level is set to the negative-going slope of the trigger signal. In its pushed state the trigger level is set to the positve-going slope.

2-3 OPERATING INSTRUCTION

2-3-1 Display Mode

The DISPLAY switch allows the selection of four modes of operation; A, A INTE, DLY'D(B) and ALT.

A

A Sweep is provided at the sweep rate set by the A TIME/DIV switch and the A VARIABLE control. Operation for triggering A sweep is provided with the switches and controls of the A TRIG. This mode is used for observing the ordinary waveforms.

A INTEN

A Sweep intensified by B Sweep is provided. This mode is used to select the magnified portion of display in the delay-sweep. The sweep rate of A Sweep is set by the A TIME/DIV switch and the A VARIABLE control, and the width of B Sweep (sweep rate) is set by the B TIME/DIV switch.

DLY'D(B)

A portion intensified in the A INTEN mode is fully displayed on the CRT. Operation for triggering is provided with the switches and controls of the B TRIG, and the sweep rate is set by the B TIME/DIV switch.

ALT

The ALT mode is obtained when both of the A INTEN and DLY'D(B) buttons are pushed in, and alternate display of the A INTEN and DLY'D(B) sweeps is provided.

2-3-2 A Triggering

The input waveforms cannot be observed without triggering, therefore the correct operation for triggering must be understood sufficiently.

This section first describes the triggering procedure of A Sweep, and then the operating instruction of the controls and connectors used for triggering. As to the triggering method of B Sweep, refer to "Delay Triggering" of this instruction manual.

Triggering Procedure I (Internal Triggering)

1. Set the INT-EXT÷10-LINE-EXT switch to INT.
2. Select a unit to supply the trigger signal by the TRIG SOURCE switch of the Main Frame.
3. Select a channel to supply the trigger signal by the TRIGGER switch of the V unit.
4. Set the display amplitude of the input signal (trigger signal) to a value higher than prescribed one shown in Table 1-1-1.
5. Select a coupling by the AC-LF REJ-HF REJ-DC switch.
6. Set the MODE switch either to AUTO or NORM depending on measuring object.
7. Select a trigger slope and trigger level by the A LEVEL control.
8. Confirm that the triggering has been correctly set by the A TRIG'D indicator.
9. Adjust the A HOLDOFF control when the waveform is displayed in duplication even if a stable triggering is obtained, in observation of a complex waveform.

Triggering Procedure II (External Triggering)

1. Set the INT-EXT÷10-LINE-EXT switch to EXT or EXT÷10.
2. Connect the external trigger signal to the TRIG IN connector. (See Figure 2-2-1)
3. Select a coupling by the AC-LF REJ-HF REJ-DC switch, according to the external trigger signal applied.
4. Set the MODE switch to either AUTO or NORM depending on measuring object.

5. Select a trigger slope and trigger level by the A LEVEL control.
6. Confirm that the triggering has been correctly set by the A TRIG'D indicator.
7. Adjust the A HOLDOFF control where it is necessary.

Triggering Procedure III (Line Triggering)

1. Set the INT-EXT÷10-LINE-EXT switch to LINE.
2. Set the MODE switch to NORM.
3. Set the AC-LF REJ-HF REJ-DC switch to AC.
4. Select the trigger slope and trigger level by the A LEVEL control.
5. Confirm that the triggering has been correctly set by the A TRIG'D indicator.
6. Adjust the A HOLDOFF control where it is necessary.

Trigger Source

In order to observe the input signal waveform on the viewing area by triggering, the input signal itself or a signal having an integer relationship with respect to the input signal in frequency (which is called a trigger signal) must be supplied to the trigger circuit in order to actuate the trigger generator which sends a trigger pulses and conducts the horizontal sweeping of display.

Setting the INT-EXT÷10-LINE-EXT (Source) switch to INT allows internal triggering which uses a sample of the input signal from the V unit as the trigger signal. Line triggering is obtained by setting the Source switch to LINE. In this case, the line frequency signal is supplied from the power supply circuit to the trigger circuit as the trigger signal. External triggering is obtained by setting the Source switch to EXT or EXT÷10.
In this case, the trigger signal is obtained from signal connected to the TRIG INPUT connector.

In the internal triggering, adequate amplitude of trigger signal is obtained by connecting the signal to be measured to the INPUT connector and selecting the deflection factor because the trigger signal is supplied from the vertical deflection system to the trigger circuit. Therefore, triggering can be obtained even if the input signal is comparatively small.

In the line triggering, line frequency signal is directly supplied from the power supply circuit to the trigger circuit. Therefore, the line triggering provides a stable triggering for measurements of line frequency signals or its harmonics in simple operation.

The external triggering offers the following unique features.

First, the external triggering is free from influence of vertical deflection settings. In the internal triggering, trigger signal amplitude varies according to the deflection factor and the LEVEL control needs to be adjusted to resume proper triggering level.
On the other hand, the external triggering needs no readjustment of the LEVEL control against any changing of deflection factor so long as the external trigger signal amplitude is retained unchanged.

Second, when it is desired to start the sweep a certain time before or after the input signal, the desired waveform can be displayed by using a signal of such timing as an external trigger signal.

Trigger Coupling

There are various trigger signals; DC signals, AC signals, signals superimposed on DC, signal superimposed by high frequency noise, etc. In order to give stable triggering to these signals, the trigger coupling should be selected by the AC-LF REJ-HF REJ-DC switch.

The AC coupling is used for the ordinary trigger signals. When the unnecessary frequency components are contained in the trigger signals, select the LF REJ coupling or the HF REJ coupling depending on the components contained in the frequency. When the repetition rate of the trigger signal is less than 30 Hz or when the trigger signal is the non-repetition signal, the DC coupling is used.

Sweep Mode

The three modes of operation can be selected by the MODE switch; AUTO, NORM and SINGLE. The description here deals with the settings of AUTO and NORM which are related with the triggering. The SINGLE mode of operation will be described later in "Single Sweep Operation".

In either mode of AUTO or NORM, the triggering is available at a certain range right or left from the center line of the LEVEL control and this range varies depending on the amplitude of the trigger signal. In the AUTO mode, free-running sweep is given when no triggering is

obtained, in other words, when the LEVEL control is set beyond the triggering range, or in the absence of trigger signal. Accordingly, since the trace is available at a ground level if the input coupling of the V unit is set to GND, this ground level can be used as a reference level of the measurement. The signals below about 50 Hz cannot be triggered in the AUTO mode. In such case, use the NORM mode. In the NORM mode, the sweep stops when the triggering is not available.

Trigger Slope and Trigger Level

The selection of the slope to be triggered and the setting of the trigger level are made by the LEVEL control. In the pushed state of the LEVEL control, the trigger level is set to the positive-going slope of the trigger signal. By pulling the LEVEL control, the trigger level is set to the negative-going slope. After the trigger slope is selected, set the trigger level.

Holdoff Time

When the input signal has a complicated pulse train, the pulse train may be displayed in duplication in a certain sweep rate even if the triggering is obtained correctly.

In such case, the HOLDOFF control is useful. The duplication can be eliminated by turning the HOLDOFF control slightly clockwise from the fully counterclockwise position.

2-3-3 Sweep Rate

The signals to be measured vary in many ways, from high to low repetition frequencies, or from fast to slow rise time pulses. In order to measure such signals, a suitable sweep rate must be selected according to the repetition frequencies or the rise time.

The sweep rate of the A sweep is the value selected by the A TIME/DIV switch when A VARIABLE is set at the fully clockwise position, CALIB. Each setting value is slowed down when turning the A VARIABLE control counterclockwise, and becomes less than 1/2.5 of the value when it is set at the fully counterclockwise position.

The signals to be measured vary in many ways, from high to low repetition frequencies, or from fast to slow rise time pulses. In order to measure such signals, a suitable sweep rate must be selected according to the repetition frequencies or the rise time.

The sweep rate of the B Sweep is always calibrated to the value indicated by the B TIME/DIV switch as no variable control is presented.

2-3-4 Delay Sweep

The sweep magnification operated in the Main Frame is simple in operation and useful to make the maximum sweep rate 10 times faster than the setting value of the TIME/DIV switch. However, the magnification factor is limited to 10 times. In the case of sweep magnification by the delay operation, the limitation of magnification factor can be enlarged to an extent determined by the ratio of A weep rate to B sweep rate.

Note that the magnification by the delay sweep has a limitation by applicable input signal frequencies. In other words, if the input signal frequency is so high that the A TIME/DIV switch is set to the highest speed position before magnification, no further magnificaiton is obtainable.

It should be understood that the sweep magnification by the delay is very useful for magnifying an arbitrary portion of comparatively low frequency signals.

The magnification by the delay includes the following two modes: automatic sweep and triggered sweep.

Automatic Sweep

The operating procedure is as follows:

1. Set the DISPLAY switch to A.
2. Apply the signal to be measured to the Input Connector and set the controls for a stable triggering.
3. Set the B TIME/DIV switch to a faster range than that determined by the A TIME/DIV switch.
4. Set the B LEVEL control to the fully counterclockwise position, AUTO.
5. Set the DISPLAY switch to A INTEN.
6. Turn the lock knob counterclockwise to unlock and rotate the DELAY TIME MULT dial clockwise. As an intensified portion (magnified portion) appears, which continuously moves to the right, set this intensified portion to the portion desired to be magnified.
7. Set the DISPLAY switch to DLY'D(B) to magnify. The sweep rate of the DLY'D(B) sweep is deter-

mined by B TIME/DIV. The magnification increases by making faster sweep rate.

8. The delay time of the magnified portion is calculated by (Setting value by A TIME/DIV) x (Setting value by DELAY TIME MULT).

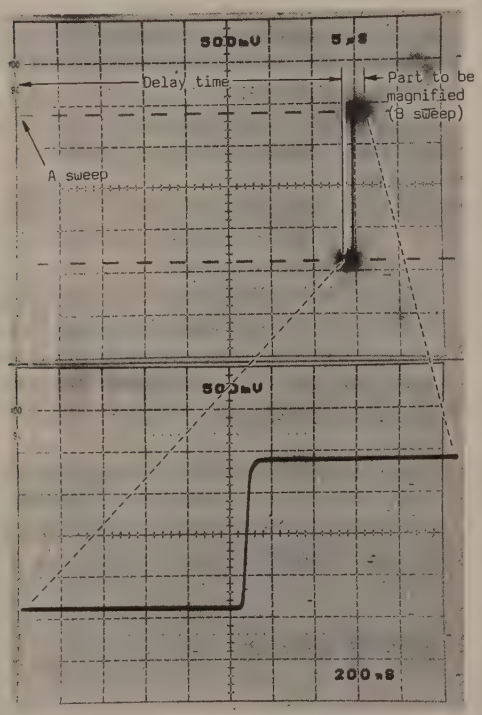
In item 7, making excessive fast sweep rate causes a delay jitter. Therefore, the magnification by the automatic sweep is limited by the delay jitter. But, magnification factor can be more increased by the triggered sweep which will be described later.

Triggered Sweep

The triggered sweep operation should follow after the automatic sweep operation.

1. Select the trigger signal source by the INT-EXT switch of B TRIG.

Figure 2-3-1. Magnification by Automatic Sweep



2. When the INT-EXT switch is set to INT, set the display amplitude of the input signal to a value higher than prescribed one shown in Table 1-1-1, and when it is set to EXT, apply the external trigger signal to the TRIG IN connector.
3. Select a coupling by the AC-DC switch of B TRIG corresponding to the trigger signals.
4. Rotate the B LEVEL control clockwise from the AUTO position and set the trigger level.
5. Set the DISPLAY switch to A INTEN, rotate the DELAY TIME MULT dial to set the intensified portion to the portion desired to be magnified.
6. Set the DISPLAY switch to DLY'D(B) to magnify it.

In the triggered sweep, B Sweep starts from the trigger point of B Sweep itself after the delay time is set by the DELAY TIME MULT dial. Accordingly, this starting point is no other point than the trigger point, which can no longer be continuously variable by the rotation of the DELAY TIME MULT dial. Due to this, no delay jitter appears in the triggered sweep.

B Triggering

Among the controls for B Triggering, there are the AC-DC switch, the INT-EXT switch, the TRIG IN connector and the B LEVEL control.

AC-DC: Same as the description of the A TRIG coupling switch.

INT-EXT: Same as the description of the A TRIG source switch. The TRIG IN connector is compatible both for A TRIG and B TRIG.

B LEVEL: Same as the A LEVEL control so far as a function of the trigger level control and the slope selector switch is concerned. Another function is the function to select the delay sweep mode, where the automatic sweep delay is available with fully counter-clockwise position, AUTO and the triggered sweep delay is possible with a certain range from the mid-range of the control.

2-3-5 Alternate Sweep

In the ALT sweep, the A INTEN sweep and the DLY'D(B) sweep are displayed alternately. It is convenient that the portion of the waveform to be magnified and the magnified portion can be simultaneously observed.

The ALT mode is available by pushing in both buttons of A INTEN and DLY'D(B), and the A INTEN sweep and the DLY'D(B) sweep appear on the CRT. Accordingly, succeeding to the operation of the delay sweep, display the ALT sweep, and the portion to be magnified and the magnified portion can be traced. Since in the ALT sweep the vertical position of the A INTEN sweep can be adjusted by the TRACE SEP control, set both sweeps to the easily viewable position by adjusting the vertical position control of the V unit, together with this control.

2-3-6 Single Sweep

Many transient effects are seen in daily service such as chattering of relay contact or discharging waveform. Such transients can be observed correctly by using the single sweep function in which sweeping of display takes place only once when triggered and by photographic recording.

Its operating procedure is as follows;

1. Set the DISPLAY switch to A.
2. Set the MODE switch to AUTO or NORM.
3. Apply the transition phenomena to be measured or other signals, and set the controls for a stable triggering.
4. Set the MODE switch to SINGLE and push the RESET (SINGLE) button to confirm that the sweep is made once.
5. Stop the oscillation of the single and push the RESET button. After this operation, confirm that the READY indicator is lit. The READY light indicates that the sweep is in ready state (to sweep once upon receipt of the trigger signal). (One point near the midrange of the LEVEL control may not be in the ready state, but in this case, rotate the LEVEL control a little either clockwise or counterclockwise.)
6. Oscillate the signal.

If the external trigger signal is made into a signal pulse in coincident trigger with the transient phenomena to be measured, even external signals can be traced by a single sweep. The simultaneous single sweep of such phenomena should be traced by the CHOP mode of operation.

2-4 MEASURING INSTRUCTION

Of the oscilloscope measuring functions available in combination use of the H-830 unit with the corresponding Main Frame and the V unit, the basic measuring method regarding the function of the H-830 unit is described as follows:

2-4-1 Time Measuring Equation

The time between any two points of the waveform can be calculated by Equation (1) from the setting values of A or B TIME/DIV switch and the sweep magnifier switch of the Main Frame, after the A VARIABLE control is set to the CALIB position (this operation is unnecessary for B sweep);

Time (s) = Setting value of TIME/DIV (s/div)
x Distance between points to be measured (div)
x Reciprocal number of setting value of sweep magnifier ..... (1)

where, "Reciprocal number of setting value of sweep magnifier" is 1 if not magnified, and when magnified, for example in 10 times magnification it is 1/10.

When reading the setting value of the TIME/DIV switch from the readout display, it is not necessary to multiply "Reciprocal number of setting value of sweep magnifier" in Equation (1).

2-4-2 Measuring Range

The accuracy of the sweep rate of the H-830 unit is specified over center 8 division area on the CRT. (See Figure 2-4-1) Therefore, accurate time measurement must be made within this range.

If the starting point of the measuring interval of the waveform is aligned to the 1st vertical line by adjusting the horizontal position control and the final point is set within the 9th vertical line by changing over the TIME/DIV switch, the measurement within that range is possible.

2-4-3 Time Interval

The time interval between two points of the waveform is measured as follows:

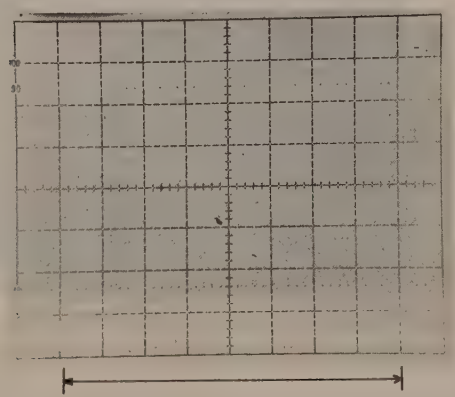
1. Apply the signal to be measured to the input connector of the V unit.
2. Select the unit and the channel to which the signal is applied by the mode switches of the Main Frame and the V unit.
3. Set the display amplitude of the signal to about 4 divisions and set the controls for a stable triggering.
4. Adjust the horizontal position control, change the TIME/DIV switch, sweep magnify it where necessary to set the interval to be measured within the center 8-division area.
5. Adjust the vertical position control to align the 2 points of interval to be measured to the center horizontal line. (See Figure 2-4-2).
6. Read the interval to be measured and calculate it by Equation (1).

<Example>

Supposing that the measuring interval is 3.4 div, the setting value of the TIME/DIV switch is 500 nSEC, and being magnified,

Time interval (ε) = 3.4 div x 500 ns/div x 1/10 = 17 μs

Figure 2-4-1. Measuring Range



2-4-4 Pulse Width

The pulse width is measured as follows:

1. Apply the pulse to be measured to the input connector of the V unit.
2. Select the unit and the channel to which the signal is applied by the mode switches of the Main Frame and the V unit.
3. Set the display amplitude of the pulse to 4- or 6-division area, and set the controls 4 or 6 division area, and set the controls for a stable triggering.
4. Adjust the horizontal position control, change the TIME/DIV switch, sweep magnify it where necessary to display the pulse within the center 8-division area.
5. Read the width of the pulse at the intersecting point where the rising and falling edges of the pulse meets the center horizontal line, and calculate it by Equation (1).

Figure 2-4-2. Measurement of Time Interval

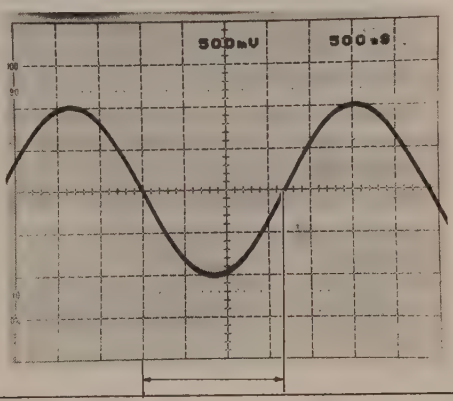
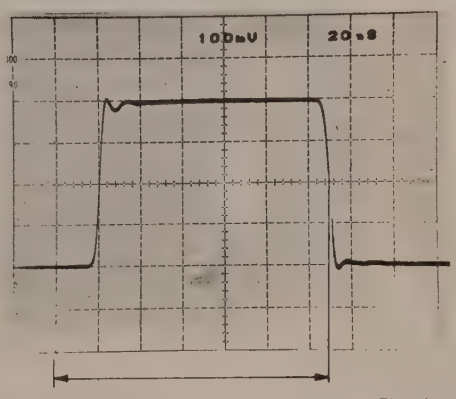


Figure 2-4-3. Measurement of Pulse Width



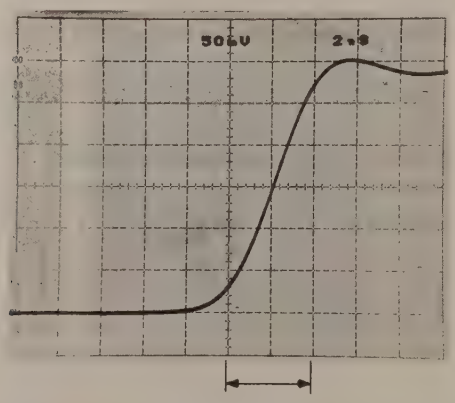
<Example>
Supposing that the interval of the pulse width on the CRT is 5.5 div, the setting value of the TIME/DIV switch is 20 nSEC, and being not magnified,
Pulse width = 5.5 div x 20 n/div = 110 ns.

2-4-5 Rise Time

The rise time of the pulse is measured as follows:

1. Apply the pulse to the input connector of the V unit.
2. Select the unit and the channel to which the signal is applied by the mode switches of the Main Frame and the V unit.
3. Set the display amplitude of the pulse to 6 divisions, adjust the vertical position control to align the pulse to the center 6-division area. (See Figure 2-4-4)
4. Set the controls for a stable triggering, and change over the TIME/DIV switch, sweep magnify it where necessary to make measurable width of the rising and falling edges.
5. Align the 10% point of the rising (falling) edge to any vertical line within the center 8-division area by adjusting the horizontal position control.
6. Read the width from 10% to 90% and calculate it by Equation (1).
<Example>
Supposing that the width from 10% to 90% is 2 div, the setting value of the TIME/DIV switch is 20 nSEC, and being magnified,
Rise time (s) = 2 div x 20 ns/div x 1/10
= 4 ns

Figure 2-4-4. Measurement of Rise time



2-4-6 Frequency

The frequency is measured as follows:

1. Measure the period of one cycle as mentioned in "Time Interval".
2. Calculate the frequency by Equation (2).

$$\text{Frequency (Hz)} = \frac{1\ (c)}{\text{Period (s)}} \quad \cdots\cdots\cdots\cdots (2)$$

<Example>
Supposing that the 1 cycle of frequency is 5 ms,

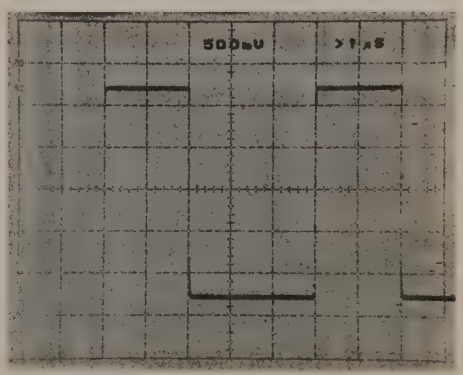
$$\text{Frequency (Hz)} = \frac{1}{5 \times 10^{-3}} = 200 \text{ Hz}$$

2-4-7 Duty Ratio

It is convenient to use the A VARIABLE control in measuring the duty ratio of the pulse, etc.

1. Apply the signal to be measured to the input connector of the unit.
2. Select the unit and the channel to which the signal is applied by the mode switches of the Main Frame and the unit.
3. Set the DISPLAY switch to A.
4. Set the display amplitude of the signal to about 5 division and set the controls for

Figure 2-4-5. Measurement of Duty Ratio



a stable triggering.

5. Align the rising edge of the signal waveform to the 2nd or 3rd vertical line by adjusting the horizontal position control.
6. Change over the A TIME/DIV switch, sweep magnify it where necessary and adjust the A VARIABLE control to set the width of one cycle to 5 division.
7. If the width of the first or last half cycle is multiplied by 2, the multiplied value is the % value and represents the duty ratio.
   <Example>
   In the case of Figure 2-4-5, the width of the first half cycle is 2 div. The duty ratio is 2 x 20 = 40%.

Section 3 Circuit Description

3-1 BLOCK DIAGRAM OF H-830

Caution

In the sentences below, the number provided in Square (☐) refers to the number shown in the circuit diagrams.

The block diagram of H-830 is shown in Figure 4-1-1.

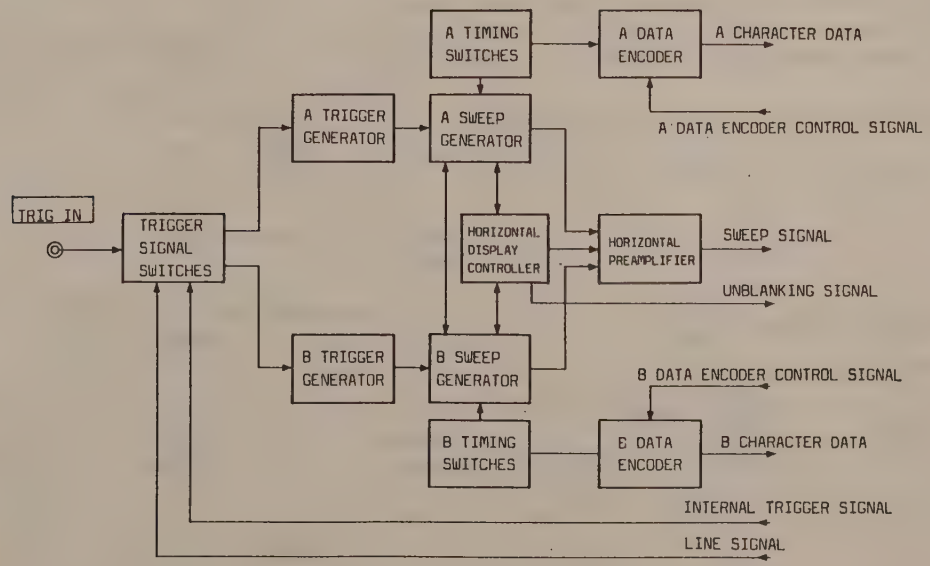
[1] TRIGGER SIGNAL SWITCHES consist of SOURCE and COUPLING switches for A and B triggers.
[2] A TRIGGER GENERATOR generates the trigger pulse and initiates [3] A SWEEP GENERATOR in the next step.
[3] A SWEEP GENERATOR generates the ramp signal determined by the DC constant current and the timing capacitor selected by [6] TIMING SWITCHES and the ramp signal results in the time base of oscilloscope. This ramp signal is applied to the next [7] HORIZONTAL PREAMPLIFIER. [3] A SWEEP GENERATOR also applies the ramp signal as a delaying sweep to [5] B SWEEP GENERATOR.

When using the delayed sweep in TRIGGERABLE mode, [4] B TRIGGER GENERATOR generates the trigger pulse, that initiates the next [5] B SWEEP GENERATOR. [5] B SWEEP GENERATOR generates the ramp signal determined by the DC constant current and the timing capacitor selected by [6] TIMING SWITCHES.

Depending on the condition of horizontal display the [7] HORIZONTAL PREAMPLIFIER selects A or B sweep signals, and amplifies them and applies them to the main frame. The HORIZONTAL DISPLAY CONTROLLER manages the unblanking signal which is applied to Z-amplifier of the main frame.

A and B DATA ENCODERS send the character code to the main frame to display the scale factors of the sweep time on the CRT.

Figure 3-1-1 BLOCK DIAGRAM



3-2 TRIGGER SIGNAL SWITCHES [1]

3-2-1 Function

TRIGGER SIGNAL SWITCHES select the signal source and the method of coupling of the trigger signal for A and B TRIG GENERATORs.

Since only one external trigger input is provided, this circuit distributes the external trigger signal to A and B trigger generators like the internal trigger signal.

3-2-2 Operation

The internal trigger signal is supplied from the mother board of the main frame (c.f. TS-8123) through the card edge connector 27A of H-830. This internal trigger signal is divided into two signals for A and B trig generators by means of transistors Q101, Q102 and Q103.

On the other hand, the external trigger signal is supplied from J103 [TRIG IN]. The external trigger signal is also divided into two signals for A and B trigger generators by means of resistors R101 and R107. As shown in Figure 3-2-2, the input resistance is 1MΩ.

A trigger source can be selected to 4 types; Internal [INT], Line [LINE], External [EXT] and External ÷ 10 [EXT ÷ 10] by operating two 4-circuits transfer type push button switches. Figure 3-2-3 shows the case of [INT]. In order to keep the input resistance of external trigger input in 1MΩ, the external trigger signal is grounded by R121, 1MΩ. Figure 3-2-4 shows the case of [LINE]. To minimize interference of the internal signal into the line signal, the unused internal signal is grounded through C116. Figure 3-2-5 shows the case of [EXT]. To minimize interference of the internal trigger signal into the external trigger signal, the power supply -15V of emitter follower Q102 is broken off. Figure 3-2-6 shows the case of [EXT ÷ 10]. The external trigger signal is attenuated to 1/10 by R103, 910KΩ, R104 110KΩ and R201 1MΩ.

Figure 3-2-2 Input resistance of external trigger input

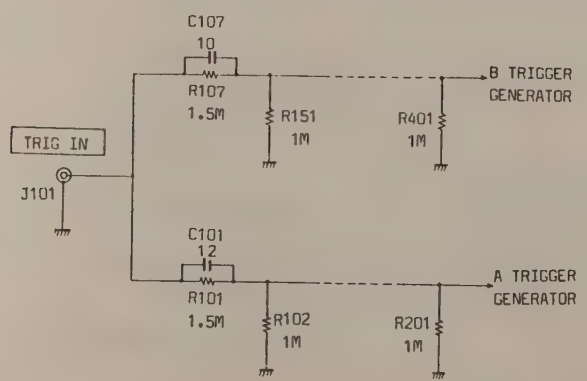


Figure 3-2-3 A TRIGGER SOURCE: INT

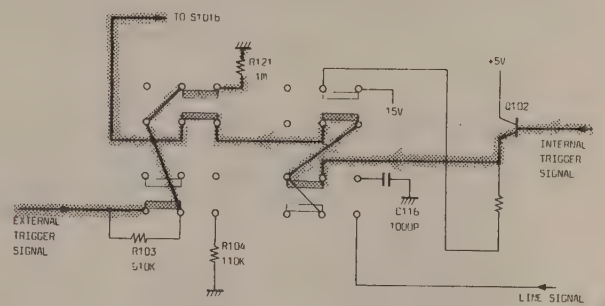


Figure 3-2-4 A TRIGGER SOURCE: LINE

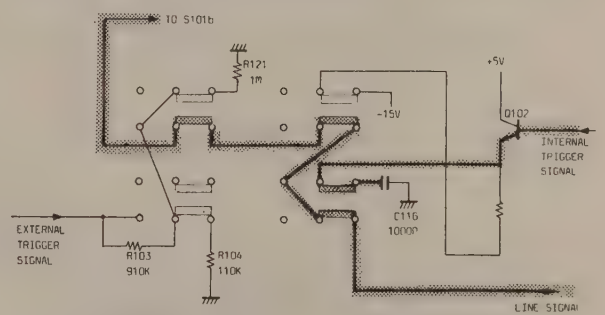
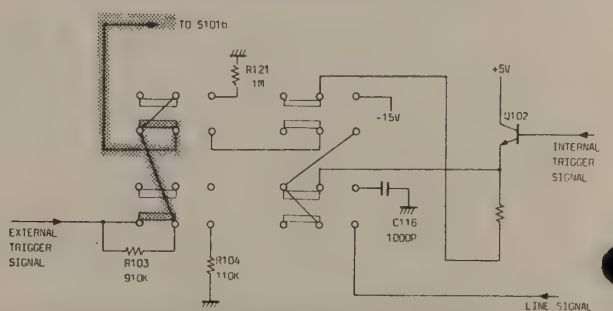


Figure 3-2-5 A TRIGGER SOURCE: EXT



The trigger signal selected by switch S101a is applied to switch S101b.

S101b can select [AC] or [DC] or [HF REJ] or [LF REJ] according to the combination of 2 switches; a 2-circuit transfer type push button switch and 4-circuit transfer type push button switch.

Figure 3-2-7 shows the case when [AC] is selected. C106 is the coupling capacitor. When [DC] is selected, the trigger signal is applied to the next stage by the direct coupling as shown in Figure 3-2-8.

As shown in Figure 3-2-9, [HF REJ] is formed under the condition of "both in" as shown in Figure 3-2-9. The low pass filter is formed by R106, 100KΩ and C108, 75pF.

With [LF REJ], the high pass filter is formed by C111 56pF and R108, 100KΩ as shown in Figure 3-2-10.

The trigger signal passes through these switches, SOURCE and COUPLING, and is led to the trigger generator.

Figure 3-2-6 A TRIGGER SOURCE: EXT÷10

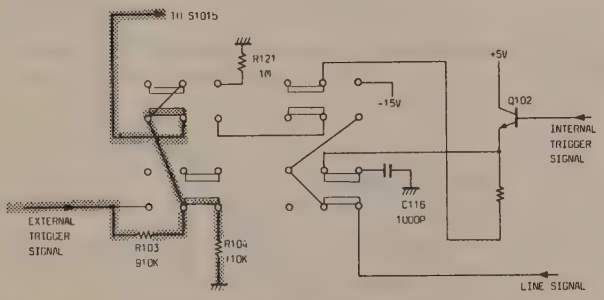


Figure 3-2-7 A TRIGGER COUPLING: AC

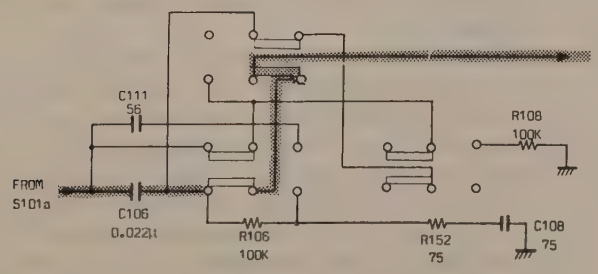


Figure 3-2-8 A TRIGGER COUPLING: DC

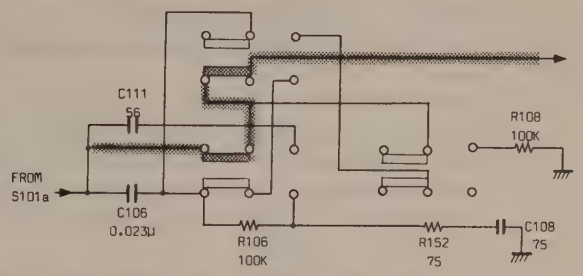


Figure 3-2-9 A TRIGGER COUPLING: HF REJ

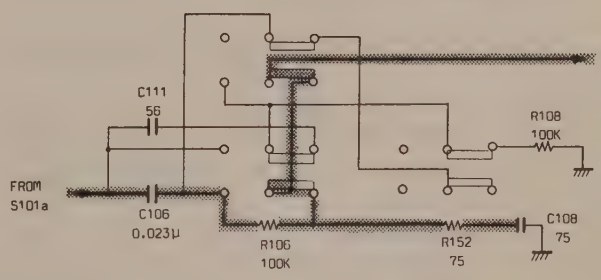
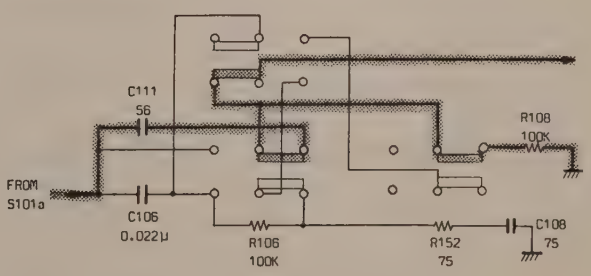


Figure 3-2-10 A TRIGGER COUPLING: LF REJ



3-3 A TRIGGER GENERATOR [2]

3-3-1 Function

A TRIGGER GENERATOR, the trigger pulse used for driving A SWEEP GENERATOR is generated from the trigger signal applied from TRIGGER SIGNAL SWITCHES. A TRIGGER GENERATOR has an additional function to eliminate jitters described as follows:

When repeatedly observing a signal, jitters may occur depending on the cycle of signal. When simultaneously with the ends of hold-off cycle the trigger pulse are generated, the gate signals fluctuate as much as the width of trigger pulse.

Figure 3-3-1 shows the case that jitters do not occur even when the jitterless circuit is not used. After the gate signal is closed, the hold-off signal is generated and after the hold-off time is completely finished, the next trigger pulse is applied. In this case, jitters do not occur.

Figure 3-3-1

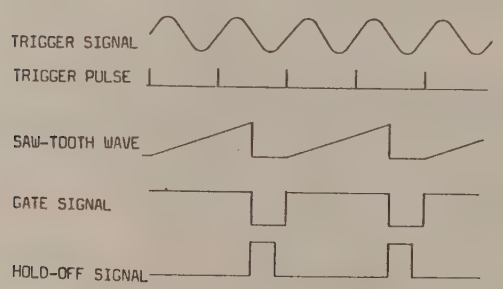
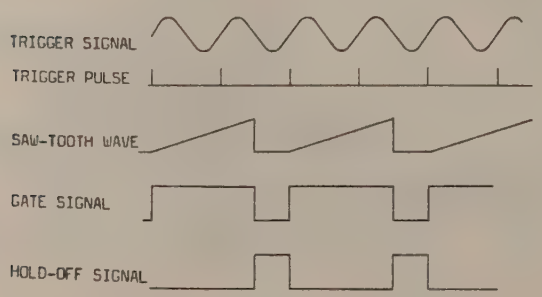


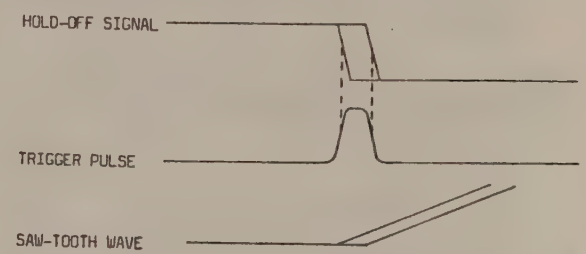
Figure 3-3-2



However, if the frequency of trigger signal is changed or the hold-off time is changed as shown in Figure 3-3-2, the end of hold off sometimes coincides with the trigger pulse occurring time. At such a time, the gates may not be opened exactly at the trigger pulse edges, or since the timing deviates at the end of the next hold-off, the start of sweep may differ each time as much as the width of trigger pulse as shown in Figure 3-3-3, and therefore, jitters occur in the waveform subject to observation.

The jitter-less circuit consisting of IC202 and IC203 prevents from such jitters which are not desired for the observation.

Figure 3-3-3



3-3-2 Operation

The signal applied from the coupling switch of A trigger is led to FET Q201 of A TRIGGER GENERATOR. The trigger signal is amplified sufficiently by the balanced amplifier consisting of Q201 - Q208 and is led to the next trigger pulse shaper consisting of the logic circuits.

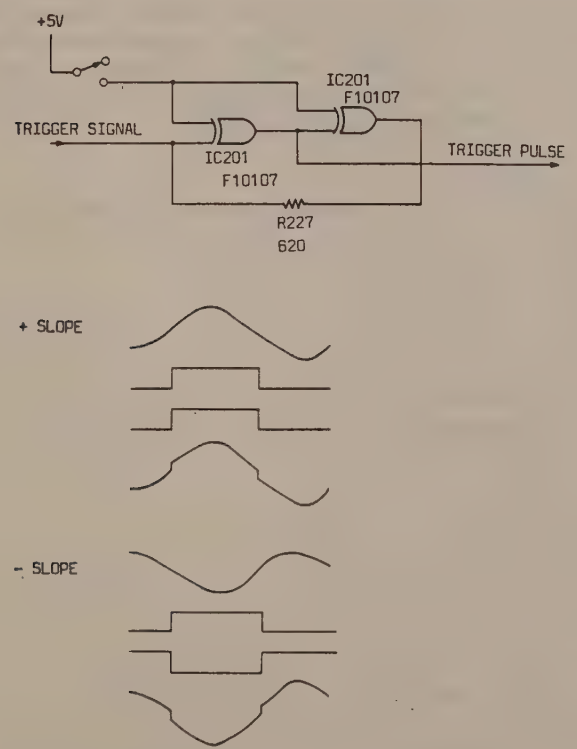
The trigger signal is applied to one of the inputs of the balanced amplifier and on the other hand, the trigger level signal is applied to Q202 for the comparison voltage with trigger signal.

The output of the balanced amplifier is derived from the collector of Q207 and this output signal is applied into the one of the inputs of EXCLUSIVE OR GATE IC202 shown in Figure 3-3-4. IC202 is ECL (emitter coupled logic), but power supply of +5V and 0V instead of 0V and -5.2V, is used in H-830. For switching the polarity of the the signal, 0V is applied to the other input for +SLOPE and +5V for -SLOPE. Also, this output is positively fedback to the input for shaping.

Since it is necessary to switch the polarity of feedback signal by switching the polarity, another EXCLUSIVE OR GATE is used. The output from IC201 EXCLUSIVE OR is applied to the CLOCK input of D type flip-flop FF1 of IC102 as shown in Figure 3-3-5. While HOLDOFF signal is being applied to R (RESET) input of FF1, the trigger pulse is not accepted, but when HOLDOFF signal is completed, FF1's Q is changed from L to H and $\overline{Q}$ is changed from H to L by the trigger pulse to be applied next. On the other hand, H has been applied to R (RESET) of FF2 by FF1's $\overline{Q}$, and therefore, FF2's Q has been outputting L regardless of the CLOCK input. As FF1's Q changes to L, the CLOCK of FF2 can be accepted. The output Q from FF2 is changed by the trigger pulse inputted next and this is the GATE signal for A sweep.

Even when the holdoff is completed as described above, the gate cannot be opened immediately. It can be opened by receiving one trigger pulse and making the arming condition. This process is as shown in Figure 3-3-6.

Figure 3-3-4



When the frequency of the signal is low, the repetitive observation is prevented from deteriorating by adding the automatic arming pulse as shown in Figure 4-1-15 instead of using the trigger pulse for arming. The automatic arming pulse is generated by one shot multi-vibration from the end of holdoff signal.

Figure 3-3-5

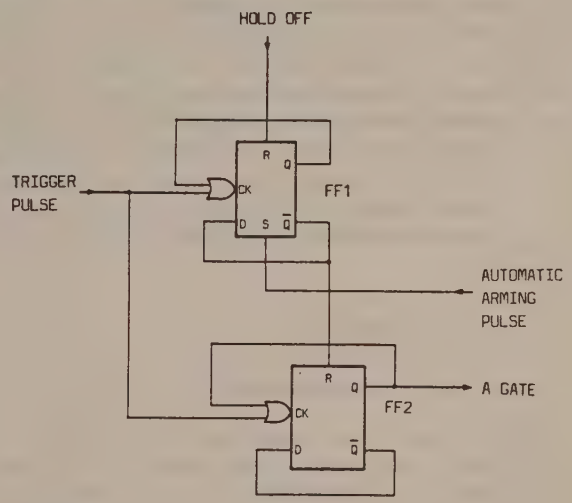
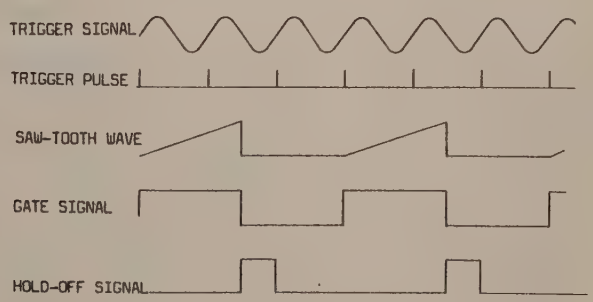


Figure 3-3-6



3-4 A SWEEP GENERATOR [3]

3-4-1 Block Diagram and Function

A SWEEP GENERATOR is as shown in the block diagram in Figure 3-4-1.

The gate signal from the trigger circuit is applied to the ramp generator through the gate circuit. The ramp generator generates a ramp signal with excellent linearity. The ramp signal is applied to the horizontal amplifier as the time based signal. The ramp signal is also applied to the holdoff circuit for controlling the amplitude of the ramp signal. The holdoff circuit generates the holdoff signal, which is fedback to the trigger circuit and the gate circuit. The gate circuit works in the function of the sweep mode by the signal from sweep mode control logic (AUTO, NORM and SINGLE).

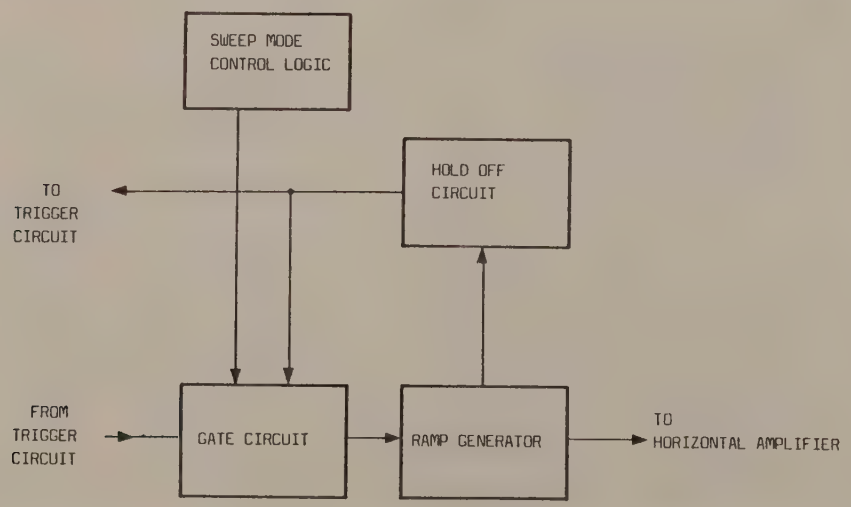
3-4-2 Operation

3-4-2-1 Ramp Generator

Figure 3-4-2 shows the principle of the generator. Depending on the stand-by condition of ramp, the GATE SIGNAL is high, and consequently D303 is "off". Q302 is "on" and the negative feedback is made by the loop of Q302, D310, Q304, Q306, R318, Q311, D308 and D307 and then the terminal voltage of timing condenser C_T is determined. The DC constant current I_T is grounded through Q302. When the gate is opened, D303 is turned "on" and Q302 is turned "off". Threfore, constant current I_T flows into the timing condenser C_T, as a result the ramp signal is generated. This ramp signal is led to the horizontal amplifier through Q304 source follower and Q306 emitter follower. When Q316 is set "off" and its collector voltage starts rising, but as Q316 is set "on", the voltage rises a very little. D310 is turned "off" and its reverse bias is kept at the constant voltage by Q316, thus keeping no change in the reverse voltage capacity, and therefore the non-linearity by the capacity variation is prevented even when the capacity of timing condenser is small at a high speed sweep. Since the abrupt change of the collector voltage of Q302 is avoided by Q316, the distortion of waveform caused by the interference of the transitional voltage into the timing condenser through the reverse capacity of D310 is prevented.

Factors causing the non-linearity are the capacity and the leakage current between gate and drain of Q304 which is forming the source follower. In this H-830, the gate-drain voltage of Q304 is always kept constant by zener diodes D309 and transistor Q317.

Figure 3-4-1 A SWEEP GENERATOR BLOCK DIAGRAM



3-4-2-2 Hold off Circuit

The functions of the holdoff circuit of H-830 are limiting the length of the ramp signal and applying an inhibit signal of a certain period to the trigger circuit. The principle of this trigger circuit is as shown in Figure 3-4-3.

The ramp signal generated by the ramp generator is applied to the base of Q310 and Q311. Since Q310 and Q311 are working as emitter followers, the base and emitter of Q312 are kept at the same electric potential, thus keeping Q312 off. The emitter of Q312 is connected to the hysterisis schmidt trigger circuit. The comparison voltage of schmidt trigger circuit decides the upper ;limit of ramp signal. When the ramp signal rises and reaches that value, the schmidt trigger circuit outputs a pulse and closes the gate of sweep generator. Therefore, the ramp generator goes down quickly to the base level. Since a holdoff condenser is connected to the emitter of Q310 through a diode, Q310 is set off when the base voltage of Q310 has gone down quickly. The base of Q312 is slowly decreased by means of the holdoff condenser and holdoff resistance. Since the emitter of Q312 follows the base voltage, Q311 is set "off" and slowly decreases with the base potential.

The hysterisis schmidt trigger circuit drops the voltage equivalent to the amount of hysterisis at the time when the holdoff signal is generated, and therefore the holdoff signal is provided until the decreasing voltage reaches this voltage. When the holdoff signal is completed, the trigger generator stands-by for the trigger pulse.

Figure 3-4-2

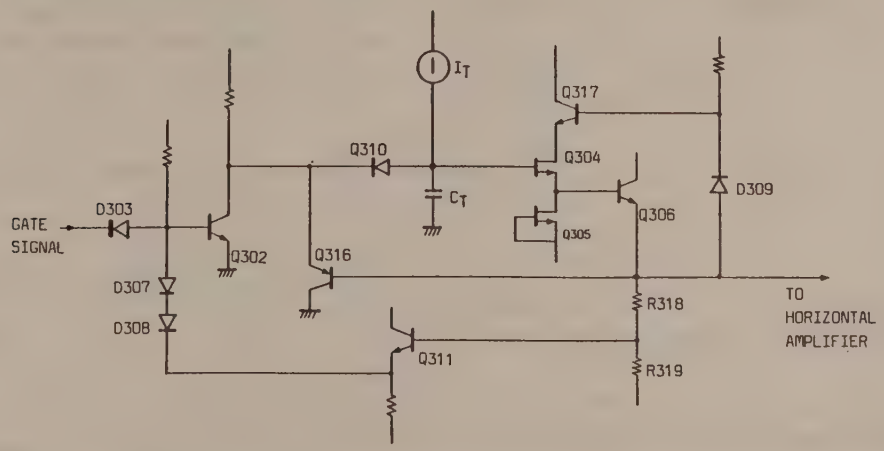
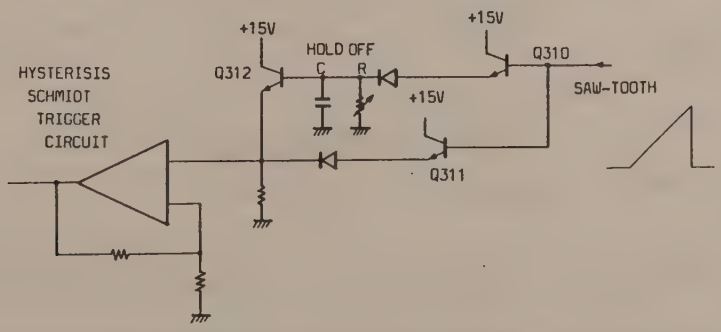


Figure 3-4-3



3-4-2-3 Gate Circuit

The GATE CIRCUIT of H-830 is used for amplifying the gate signal ... generated by the triger generator ... large enough to drive the ramp generator and for controlling free run of the sweep generator when there is no trigger pulse while automatically sweeping.

Figure 3-4-4 shows the basis and Figure 3-4-5 shows the waveform of each point.

When automatically sweeping, 1 input of Nand Gate G1 is kept H.

Under the condition that the trigger pulse is generated and the gate is opened normally, the retriggerable one shot multivibrator is triggered by $\overline{GATE}$ and $\overline{HOLDOFF}$ and its $\overline{Q}$ continuously outputs L. The output of G1 becomes H and GATE signal drives the ramp generator through Nand Gate G2 and Nand Gate G3 (when GATE is provided, HOLDOFF is not outputted), thus generating the ramp signal. As the ramp signal reaches the constant voltage, the holdoff circuit outputs HOLDOFF and clears the ramp generator through Nand Gate G3. The HOLDOFF signal triggers the retriggereable one shot multivibrator MM1 through Inverter I1 and Nand Gate G4 as in the case of GATE, thus holding its Q on L. While the trigger pulse is inputted continuously, the above operation is continued.

When the trigger pulse is absent temporarily as shown in Figure 3-4-5, Q of MM1 is raised to H after a certain period of time when HOLDOFF is completed. Then, the output of G1 becomes L and changes the output of G2 to H. Now, when

Figure 3-4-4 GATE CIRCUIT

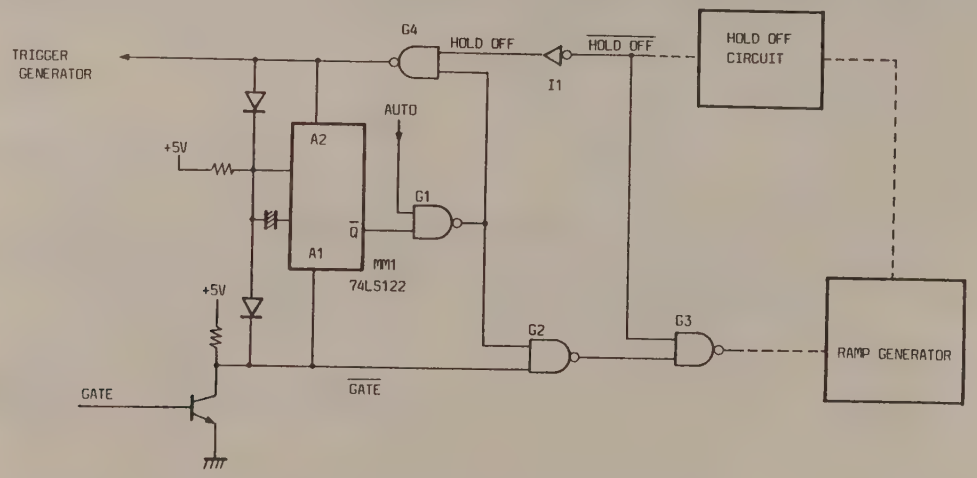
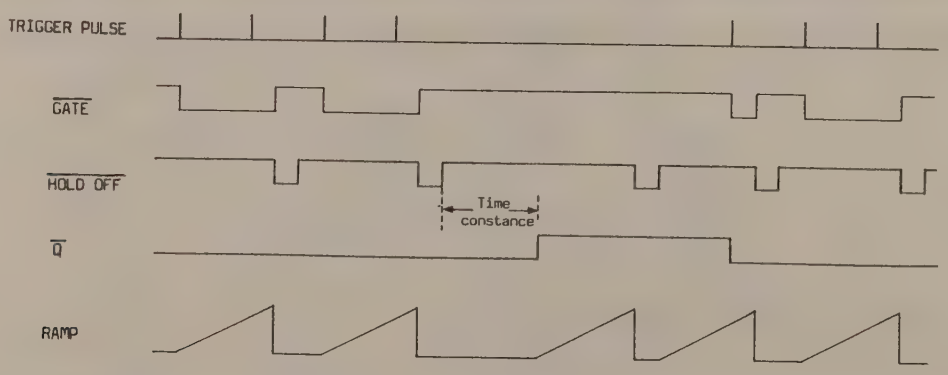


Figure 3-4-5



HOLDOFF is completed (when HOLDOFF line becomes H), the output of G3 is changed to L, drives the ramp generator and outputs the ramp signal. Since the output (L) of G1 gates G4, the holdoff signal does not trigger MM1.

Therefore, Q goes to L again when GATE is applied from the trigger generator and when the trigger pulse is generated, the free run returns to the original trigger sweep condition in the operation as shown in Figure 4-1-21.

When set to the normal sweep, 1 input of G1 becomes L, and therefore, the output of G1 is always H and even when the gate is not applied, the ramp generator is not driven by the operation of G2 and G3 at the end of HOLDOFF.

3-4-2-4 Sweep Mode Control Logic

The SWEEP MODE CONTROL LOGIC controls the sweep generator with a combination of several switches and external control signals.

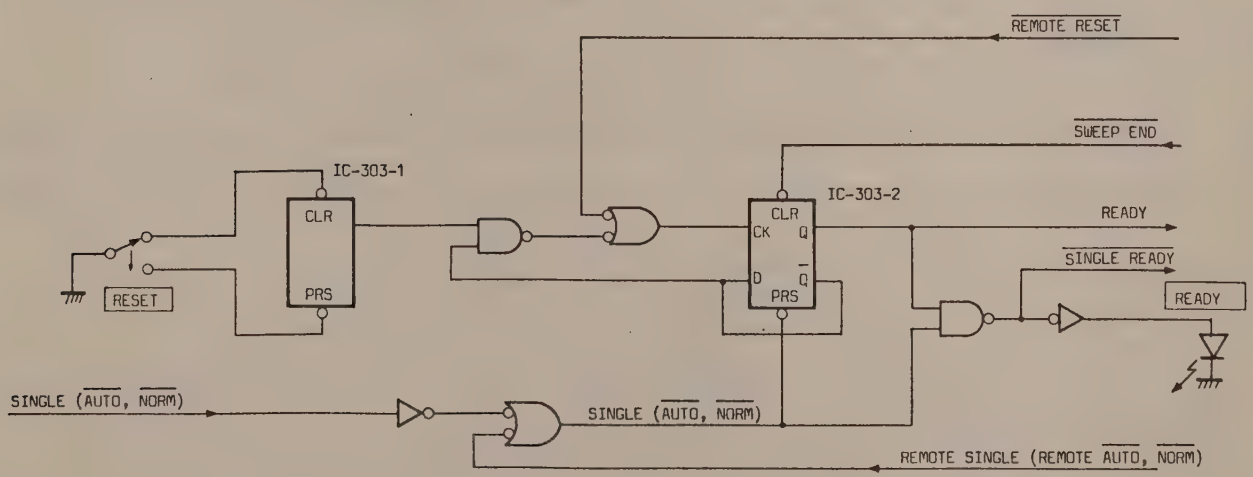
Figure 3-4-6 shows an outline of the logic.

AUTO, NORMAL, SINGLE SWEEP and SINGLE RESET can be controlled by the panel operation and the remote control signal from the main frame (TS-8123 and others).

When the single (AUTO, NORM) signal from SWEEP MODE switch or the remote single (REMOTE AUTO, NORM) signal from the main frame is applied, the preset input which had been applied to the PRS terminal of flip-flop IC303-2 is eliminated and the flip-flop can be toggled.

When it is assumed that the signal SWEEP END which notifies the sweep end is given, flip flop IC303-2 is cleared and Q turns to L. When the reset switch is pressed, chattering is absorbed by IC303-1 flip flop and is applied to CLK input of IC303-2 flip flop. The single reset can be actuated not only by the RESET switch on the front panel, but also by REMOTE RESET signal from the main frame. When the reset pulse is applied to IC303-2 CLK input, the flip-flop is reversed, thus changing Q to H. While being controlled from the main frame, it is required to notify the main frame whether the single reset is accepted or not, and therefore, a signal is outputted as a SINGLE READY signal. Indicator LED on the front panel is also lightened.

Figure 3-4-6 SWEEP MODE CONTROL LOGIC



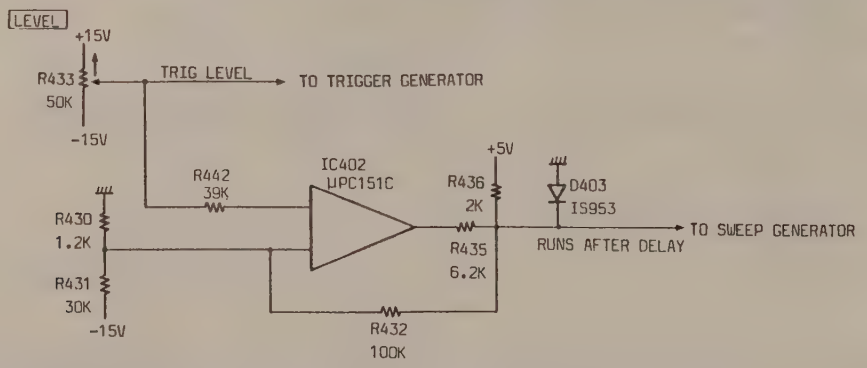
3-5 B TRIGGER GENERATOR [4]

B TRIGGER GENERATOR is opened with fundamentally the same means as that of A TRIGGER GENERATOR, except that B TRIGGER GENERATOR does not contain the jitter-less circuit, and therefore circuit of B TRIGGER GENERATOR is simpler.

Another difference between B TRIGGER GENERATOR and A TRIGGER GENERATOR is that RUNS AFTER DELAY and TRIGGERABLE are switched by operating the TRIGGER LEVEL knob in B TRIGGER GENERATOR. When the level knob is almost fully turned counter-clockwise, the condition of RUNS AFTER DELAY is set.

As shown in Figure 3-5-1, whether or not the level knob is almost fully turned counterclockwise is detected by the voltage comparator consisting of operational amplifier IC402 and others and the output signal is applied to B SWEEP GENERATOR.

Figure 3-5-1



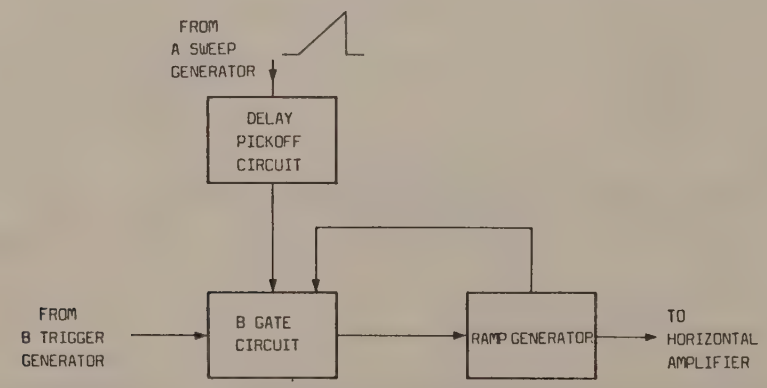
3-6 B SWEEP GENERATOR [5]

3-6-1 Block Diagram and Function

The block diagram of B SWEEP GENERATOR is as shown in Figure 3-6-1.

The delaying sweep from A sweep generator is compared with DC voltage from the delay time multiplier (DELAY TIME MULT) and the delay pick-off pulse is generated. When B Sweep Mode is RUNS AFTER DELAY, B Gate is opened when the delay pickoff pulse is generated and the time based signal is generated by the ramp generator. When B sweep mode is TRIGGERABLE, the stand-by condition is set after the delay pickoff pulse is generated and then B Gate is opened by the trigger pulse from B TRIGGER GENERATOR. The gate circuit controls these. The output from the ramp generator is led to HORIZONTAL PREAMPLIFIER.

Figure 3-6-1

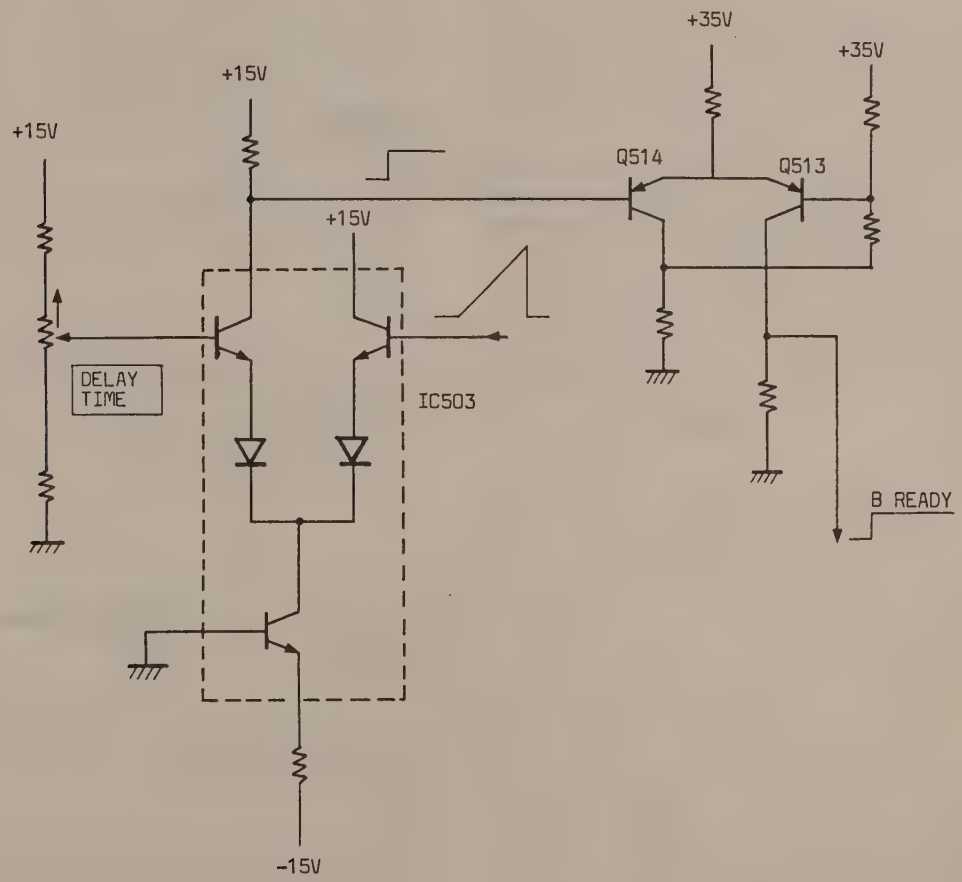


3-6-2 Operation

3-6-2-1 Delay Pickoff Circuit

The delay pickoff circuit is constructed as shown in Figure 3-6-2. The DC voltage from DELAY TIME MULT and the delaying sweep from A SWEEP GENERATOR are compared for the voltage. As the delaying sweep rises from the base voltage and becomes equal to the voltage from DELAY TIME MULT, positive (+) pulse is outputted. And this pulse is sent to the pulse shaping circuit consisting of Q514 and Q513 and made as a high speed rising pulse. This is the B READY signal and applied to GATE CIRCUIT.

Figure 3-6-2

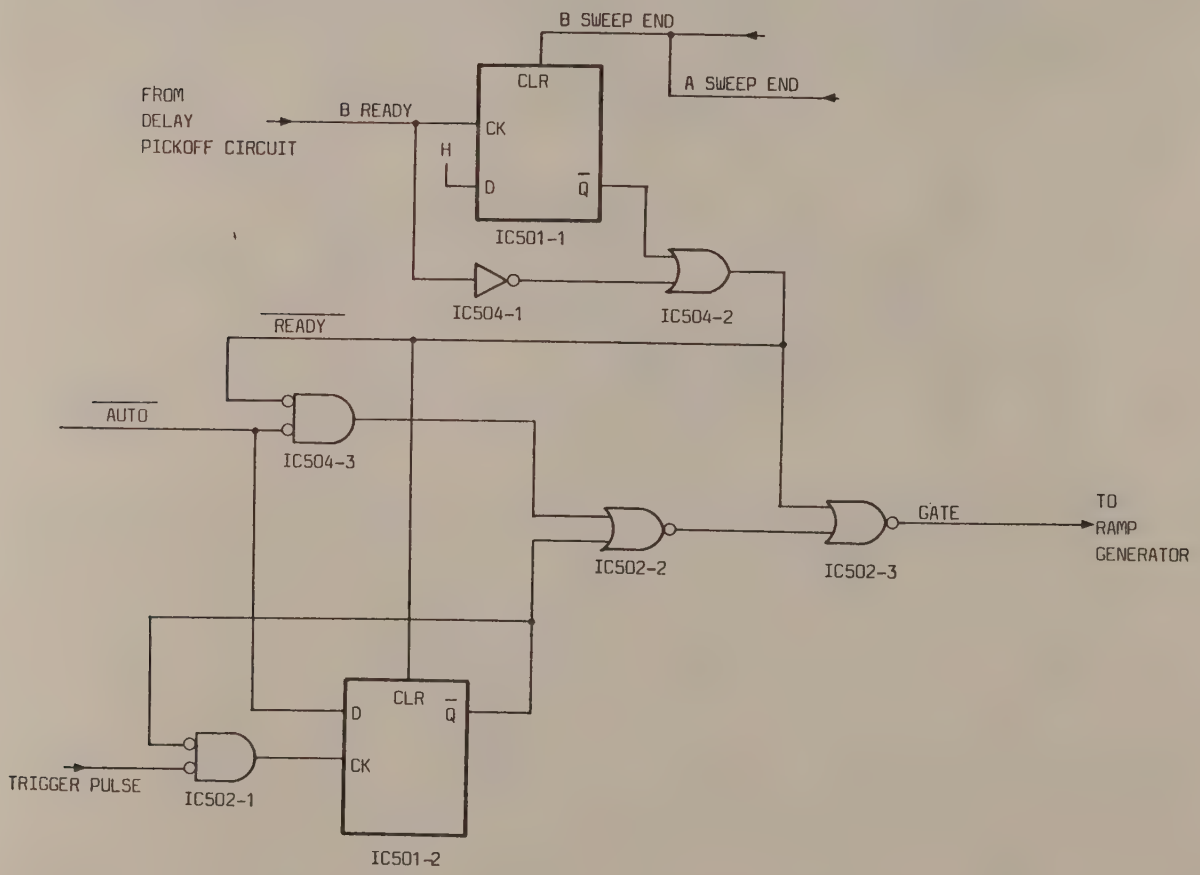


3-6-2-2 B Gate Circuit

Figure 3-6-3 shows an outline of B Gate Circuit. B Gate signal is generated by Negative NAND GATE IC502-1 and D type flip-flop IC501-2. Since B trigger pulse is not required in AUTO mode, AUTO signal is applied to D input of flip-flop IC501-2, thus always keeping the output L. The output Q is always kept L even when the clock is applied from B trigger generator or READY signal is applied to CLR input terminal of IC501-2.

At such a time, READY signal is applied to and input of IC502-3 and also to the other input of IC502-3 via IC504-3 and IC502-2, and consequently IC502-3 outputs the gate in response to B ready signal. In RUNS AFTER DELAY mode, B READY signal is generated by the delay pick-off circuit, thus outputting B GATE signal and generating B Sweep.

Figure 3-6-3



On the other hand, in the TRIGGERABLE mode (not AUTO mode), H is applied to D input of Flip flop IC501-2, and therefore H is outputted at Q. Since an input of IC504-3 is H, the output is L. As the output Q of IC501-2 is connected to an input of IC502-2 and the other input is L, rising of Q to H results in falling at the output of IC502-3. This output is connected to an input of IC502-3. As the other input is READY signal which is L at this time, falling at output of IC502-2 results in rising at output of IC502-3, and the signal becomes GATE signal.

With the gate signal, the ramp generator generates the ramp signal and when it reaches a certain level, B sweep end ... the signal which notifies the end of ramp ... is applied to CLR input of IC501-1. Output Q rises to H and READY becomes H via Gate IC504-2, thus making the not ready condition. This signal closes the gate through Gate of IC502-3. By these arrangements, the ramp generator quickly returns the ramp signal to the base level.

H of READY signal line is applied to CLR input of flip-flop IC501-2 and clears the flip-flop, and it gets ready for the trigger after the next READY.

3-6-2-3 B Ramp Generator

B Ramp Generator is fundamentally the same as A Ramp Generator. B Ramp Generator consists of the circuit of A Ramp Generator plus schmidt trigger circuit which determines the length of sweep length.

3-7 TIMING SWITCHES [6]

TIMING SWITCHES can be divided into A timing switches and B timing switches.

A timing switches are provided with a combination of a constant current source and a timing condenser for A sweep. These switches also change over the holdoff condenser.

B Timing Switches are also provided with a combination of constant current source and the timing condenser for B sweep.

A has a constant current source Q602 and B has Q604 with a group of timing resistors. Q601 and Q603 are used for temperature compensation.

A variable is operated by changing the power supply voltage which applies the current to A timing resistor.

3-8 HORIZONTAL PREAMPLIFIER [7]

In addition to the fundamental function to amplify A sweep and B sweep signals and supply them to the main frame, HORIZONTAL PREAMPLIFIER carries out the X10 magnification function.

HORIZONTAL PREAMPLIFIER consists of a balanced amplifier. Sweep signal current is applied to Q701 while H position signal current is applied to Q702. Q701 and Q702 constitute the emitter-grounded shunt feedback amplifier. The current input is converted to the voltage output. Q703 and Q704 keep the collector current of Q701 and Q702 constant and improve the linearity of the ramp signal.

Q705 and Q708 in the next step constitute an emitter grounded serial feedback amplifier. Control of X10 and X1 is performed by switching the resistance between emitters by the MAG COMMAND signal. Q710 is a constant current supply for this amplifier. Q706 and Q709 keep the voltage between emitters of Q705 and Q708 constant. Therefore, Q705 and Q708 are functioning at the constant voltage and constant current, thus forming an amplifier of excellent linearity.

Collectors of Q706 and Q709 are used as the output terminals through which the ramp signal is supplied to the main frame.

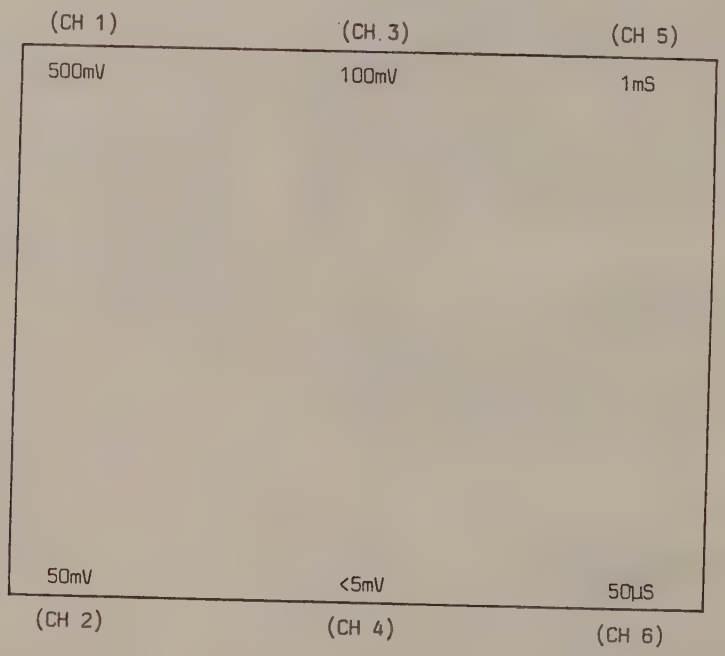
3-9 DATA ENCODERS [8], [9]

Data encoder is divided into two types; one is for A sweep and the other is for B sweep. In H-830, the data encoder is a circuit from which the character information to display the sweep time on CRT is sent to the character display circuit of the main frame. For more details of the character display circuit, refer to the manual for the main frame of TS-8123 and others.

The following is only a brief explanaiton;

H-830 is designed so that the character display functions in the normal mode, which means a mode in which 6 character strings are displayed on the CRT. When H-830 is installed in the center plug-in hall of the main frame, channel 3 and channel 4 shown in Figure 3-9-1 can be used, and the sweep time can be displayed here.

Figure 3-9-1



For the character information, 8 bit data bus and 8 control lines are used between each unit and the main frame. Data are executed by the 8 bit parallel and byte serial. Data are transmitted by the control signal as shown in Figure 3-9-2 and Figure 3-9-3.

CLOCK, SYNC and CHnAP are control signals which are sent from the main frame to each unit. Upon receiving these signals, the unit arranges a timing and sents out data. When CHnAP (channel appointment) is received, each unit sends character data (character code) according to SYNC pulse and CLOCK.

Figure 3-9-2

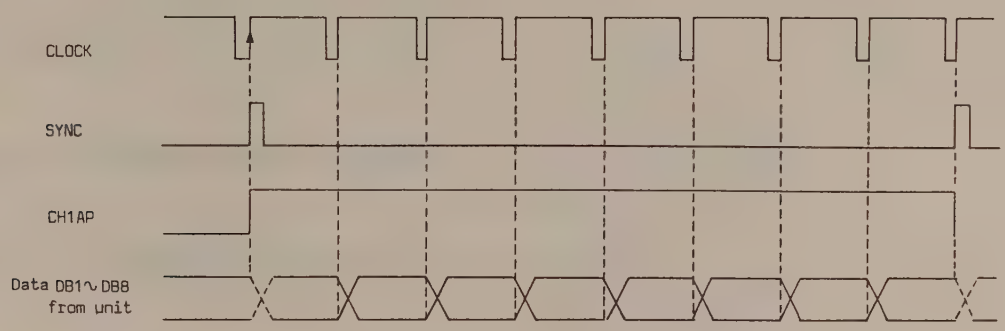
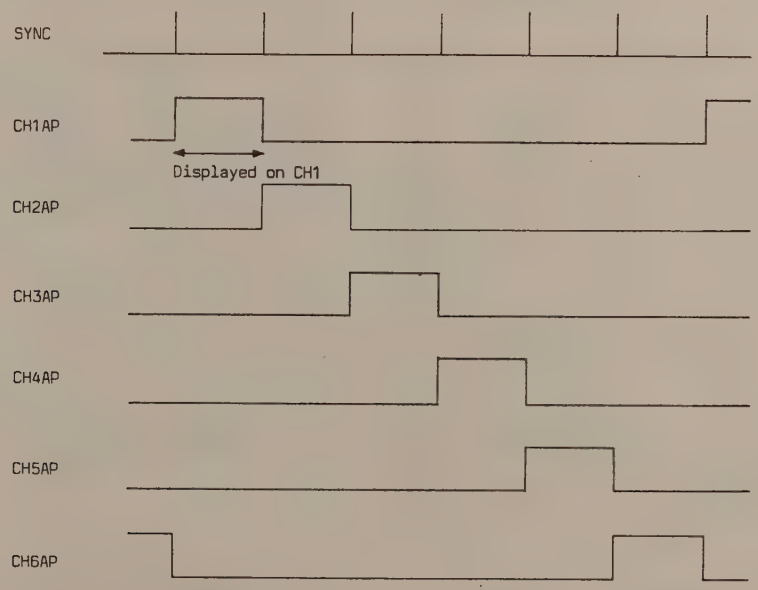


Figure 3-9-3



H-830 can display A sweep time and B sweep time, and for this purpose, character codes are generated by the data encoder. Upon receiving the informaiton from the timing switch, A outputs character code on the 8 bit data bus by data selectors IC804 - IC810 and B outputs character codes on the same bus by IC904 - IC910.

Character codes are as shown in Figure 3-9-4.

Figure 3-9-4

				0	0	0	0	1	1	1	1	DB7
				0	0	1	1	0	0	1	1	DB6
DB4	DB3	DB2	DB1	0	1	0	1	0	1	0	1	DB5
0	0	0	0		μ		Ø	@	P	.	p	
0	0	0	1		°	!	1	A	Q	a	q	
0	0	1	0		∞	"	2	B	R	b	r	
0	0	1	1		Ω	#	3	C	S	c	s	
0	1	0	0		ω	$	4	D	T	d	t	
0	1	0	1		θ	%	5	E	U	e	u	
0	1	1	0		•	&	6	F	V	f	v	
0	1	1	1		∫	'	7	G	W	g	w	
1	0	0	0		↓	(	8	H	X	h	x	
1	0	0	1		→	)	9	I	Y	i	y	
1	0	1	0		↘	*	:	J	Z	j	z	
1	0	1	1		↙	+	;	K	[	k	{	
1	1	0	0		↖	,	<	L	\	l	|	
1	1	0	1		↗	-	=	M	]	m	}	
1	1	1	0		∫	.	>	N	↑	n	~	
1	1	1	1		_	/	?	O	←	o		

Section 5 Check and Adjustment

In order to take correct measurements, each circuit in the H-830 must operate normally, and its specification must be always maintained at its best.

Periodic check and adjustment allow the H-830 to maintain its reliable specification for a long period.

This section explains how to make the check and adjustment on the H-830.

5-1 PERIOD FOR CHECK AND ADJUSTMENT

For taking measurements correctly with H-830, it is required to check and adjust it every six months.

5-2 EQUIPMENT REQUIRED

The measuring equipments and accessories thereof listed below must be prepared for the check and adjustment.

The specification of each equipment must be equivalent to or higher than that shown in the list below. Since the signal input connector of the H-830 is of the BNC type, the conversion connectors must be additionally prepared if the terminater or signal output terminal is other than BNC.

1. Scope Calibrator	Recommended model: IWATSU SC-340
2. Sine-wave Generator	
Frequency Range:	1 kHz to 20 kHz
Output Voltage:	40 mVp-p or more
	Recommended model: IWATSU FG-330
3. Digital Voltmeter	
Voltage Range:	0 to 200 V DC
	Accuracy: ±0.05% + 1 dgt
	Recommended model: IWATSU SC-7404
4. BNC Coaxial Cable	Recommended model: IWATSU BB-120C

5-3 CHECK AND ADJUSTMENT ITEMS

Items of check and adjustment described in this section are listed below. Since some items may affect the function of other items when the adjustment is made on all items or partially, it must be made in numerical order (as listed below) without fail. In addition, in checking and adjusting the H-830, use the main frame which has been already checked and adjusted in advance.

1. A TRIG LEVEL Center
2. B TRIG LEVEL Center
3. Magnification Center
4. A Sweep Rate
5. B Sweep Rate
6. Magnified Sweep Rate
7. Sweep Start
8. Delay Jitter
9. Delay Time

5-4 PRECAUTION ON CHECK AND ADJUSTMENT

In checking and adjusting the H-830, following precautions must be observed: use a cable with the characteristic impedance of 50 Ω(for example, IWATSU BB-120C), if necessary, and terminate with a 50 Ω terminator (for example, IWATSU BB-50M1) for connecting the signal generator or the like.

5-5 REMOVING THE COVER

When making the check and adjustment, the left side cover of the main frame should be removed. How to remove is described in "Removing the Cover" on Check and Adjustment of the Instruction Manual to the Main Frame.

5-6 PREPARATION FOR CHECK AND ADJUSTMENT

Before starting the check and adjustment, proceed the following preparation:

1. Set the ambient temperature at 25°C±5°C.
2. Mount the V-810 and the H-830 to the left and right plug-in holes on the main frame respectively.
3. Before turning the power on, set the switches and controls as follows:

A. Main Frame

In case of the TS-8123

POWER	OFF
INTEN	Approx. 45° to the left from the midrange
FOCUS	Midrange
ANALOG INTEN	Approx 45° to the left from the midrange
SCALE ILLUM	Fully counterclockwise
⟷ POSITION	Midrange
(PULL x 10 MAG) FINE	Center, push state
NON STORAGE REAL ONLY	Push in
DISPLAY MODE	All switch out
SCALE FACTOR	Out

In case of the SS-8120

POSITION	OFF
INTEN	Approx. 45° to the left from midrange
FOCUS	Midrange
VERT MODE	LEFT UNIT
TRIG SOURCE	LEFT UNIT
READOUT	Fully counterclockwise
POSITION	Midrange
SCALE ILLUM	Fully clockwise

B. Memory control unit (in case of the main frame TS-8123)

Y POSITION	Midrange
X POSITION	Midrange
WRITE INTERVAL	MIN, push state
WRITE LEVEL FINE	Midrange
DIGITAL LEVEL FINE	Midrange

C. Vertical Unit V-810

POSITION (CH1, CH2)	Midrange
AC-DC (CH1, CH2)	DC
VOLTS/DIV (CH1, CH2)	10 mV
MODE	CH1
VARIABLE (CH1, CH2)	CALIB
TRIGGER	CH1

D. Horizontal Unit H-830

MODE	AUTO
DISPLAY	A
A TIME/DIV	0.1 mSEC
A VARIABLE	CALIB
A LEVEL	Midrange
B TIME/DIV	50 µSEC
AC-HF REJ-LF REJ-DC	AC
AC-DC	AC
B LEVEL	AUTO
TRACE SEP	NORM

4. Set the voltage selector plug on the rear in accordance with the line voltage, and connect the power cord to the line plug socket. If the line voltage is out of range of the operating voltage of the main frame, use the voltage regulator to adjust it to be within the range.
5. Turn the power switch on, adjust the luminance intensity properly, let the trace appear on the CRT screen, and warm up for about 30 minute.

5-7 CHECK AND ADJUSTMENT PROCEDURE

5-7-1 A TRIG Center

Check and Adjustment

1. Applies the output of the OUTPUT2 of the scope calibrator to the CH1 INPUT of the V-810, and push the button located on the left of the SINE WAVE.
2. Adjust the VOLTS/DIV switch and its VARIABLE control to set the displayed amplitude to 4 divisions around the center.
3. Set the A LEVEL control to the midrange to trigger and repeat the push-pull switching of the A LEVEL (PUSH, + SLOPE; PULL - SLOPE), and check if both sweeps of positive-going slope and negative-going slope start from the same point on the CRT screen.
4. If a distance is made between the start points, adjust the R 239 A TRIG LEVEL CENT (see Figure 5-7-1).
5. Turn the AC-HF REJ-LF REJ-DC to DC, and check in the same way as in step 3 above.
6. When checking in step 5, if a distance is made between the start points, adjust the R 124 A LEVEL (see Figure 5-7-2).

5-7-2 B TRIG Center

Check and Adjustment

1. Set the switches as follows:

H-830	DISPLAY	DLY'D(B)
	A TIME/DIV	1 mSEC
	B TIME/DIV	0.5 mSEC

2. Applies the output of the OUTPUT2 of the scope calibrator to the CH1 INPUT of the V-810, and push the button located on the left of the SINE WAVE.
3. Adjust the VOLTS/DIV switch and its VARIABLE control to set the amplitude of the trace to 4 divisions around the center of the display.
4. Set the A LEVEL control to the midrange to trigger and repeat the push-pull switching of the A LEVEL (PUSH + SLOPE; PULL - SLOPE), and check if both sweeps of positive-going slope and negative-going slope start from the same point on the CRT screen.
5. If a distance is made between the start points, adjust the R 434 B TRIG LEVEL CENT (see Figure 5-7-1).
6. Turn the AC-DC to DC, and check in the same way as in step 4 above.
7. When checking in step 6, if a distance is made between the start points, adjust the R 125 B LEVEL (see Figure 5-7-2).

5-7-3 Magnification Center

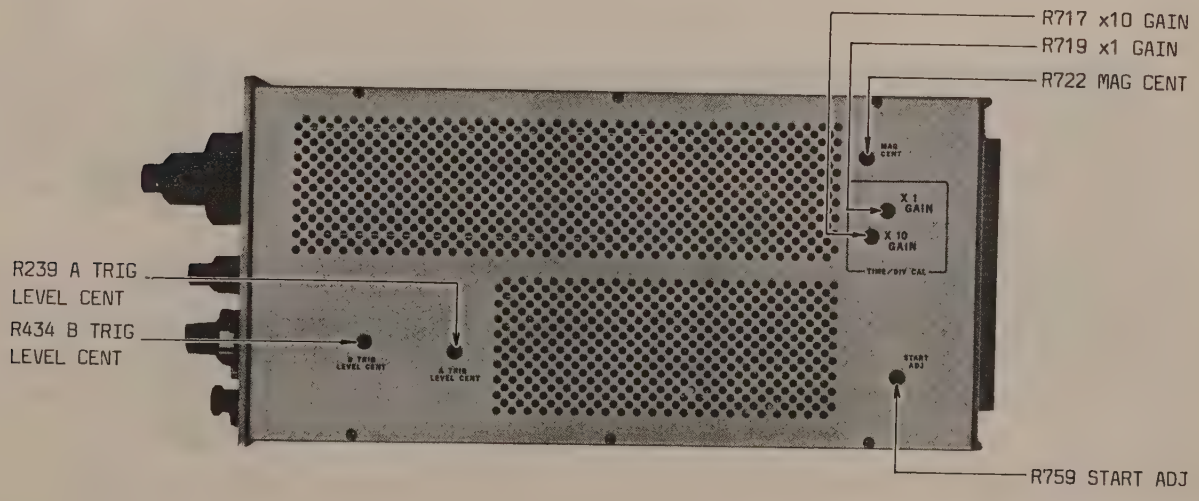
Rating:

±2 divisions or less at 1 ms/division

Check and Adjustment

1. Connect the coaxial cable between the CAL OUT 30 mV terminal and the CH1 INPUT of the V-810, and set the VOLTS/DIV switch of CH1 to 5 mV.
2. Set the A TIME/DIV switch to 1 mSEC.
3. Adjust the POSITION control to set the sweep starting point (positive-going of the CAL waveform) to the vertical center line on the CRT screen. Pull the PULL x 10 MAG FINE control, and check if the starting point shifts at this time.
4. If the starting point shifts excessively, set the starting point of the magnified sweep to the PULL x 10 MAG FINE. Then, adjust the R 722 MAG CENT (see Figure 5-7-1) to remove the deviation of the sweep starting position at this time from the vertical center line.

Figure 5-7-1. Adjustment Locations (Right)



5-7-4 A Sweep Rate

Ratings:

(I) Accuracy of sweep rate for 8 divisions around the center of the CRT screen: ±2%

(II) Accuracy of sweep rate for any 2 divisions in 8 divisions around the center of the CRT screen: ±4%

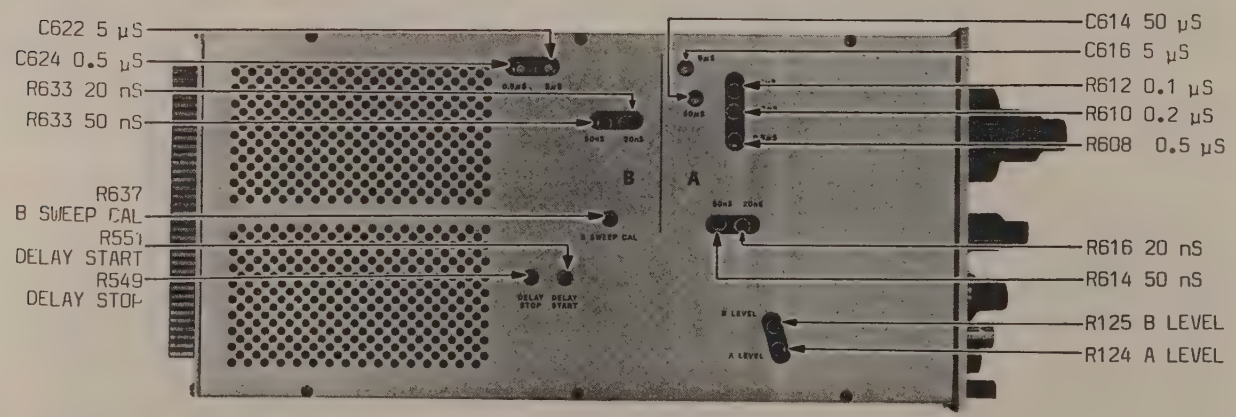
Check and Adjustment

1. Set the controls and the switch as follows:
   DISPLAY A
   SWEEP MODE NORM
2. Set the A TIME/DIV switch to 1 mSEC.
3. Applies the output of the OUTPUT 2 of the scope calibrator to the INPUT of CH1 of the V-810, push the PULSE TRAIN, and set the REPETITION to 1 mSEC.
4. Set the start pulse to a position 1 division right from the left end of the graticule. Check the errors of (I) and (II). (See Figure 5-7-3 and 5-7-4.)
5. If the errors are out of the rating, adjust the R 719 x 1 GAIN (see Figure 5-7-1).
6. In the same way, check the errors of (I) and (II) at the sweep rates from 0.5 mSEC to 10 mSEC, and from 0.5 mSEC to 0.1 mSEC after turning the REPETITION in accordance with the A TIME/DIV switch setting.
7. Change the REPETITION in the range from 0.5 µSEC to 0.1 µSEC in sequence, and check the errors of (I) and (II).
8. If out of the rating, make the adjustment while referring to Table 5-7-1 and Figure 5-7-2.
9. Push the HF of the PULSE TRAIN of the scope calibrator, and check the errors of (I) and (II) at 20 nSEC and 50 nSEC. At this time, set the 20 nS - 10 nS switch of the scope calibrator to 20 nS.
10. If out of the rating, make the adjustment, referring to Table 5-7-1 and Figure 5-7-2.

Table 5-7-1. Adjustment of A Sweep Rate

A TIME/DIV	Adjustment
1 mSEC	R719
20 nSEC	R616
50 nSEC	R614
0.1 µSEC	R612
0.2 µSEC	R610
0.5 µSEC	R608
5 µSEC	C616
50 µSEC	C614

Figure 5-7-2. Adjustment Locations (Left)



5-7-5 B Sweep Rate

Ratings:

(I) Accuracy of sweep rate for 8 divisions around the center of the CRT screen: ±2%

(II) Accuracy of sweep rate for any 2 divisions in 8 divisions around the center of the CRT screen: ±4%

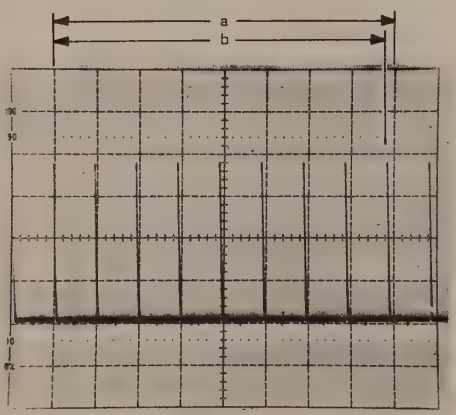
Check and Adjustment

1. Set the controls and switch as follows:
   DISPLAY A INTEN
   SWEEP MODE NORM
   B TRIG AC
2. Set the A TIME/DIV switch to 2 mSEC, and B TIME/DIV switch to 1 mSEC.
3. Applies the output of the OUTPUT 2 of the scope calibrator to the INPUT of CH1 of the V-810, push the button located on the left of the PULSE TRAIN, and set the REPETITION to allow the triggering.
4. Set the DISPLAY switch to DLY'D (B), and set the start pulse to the position 1 division right from the left end of the graticule. Then, check the errors of (I) and (II).
5. If out of the rating, adjust the R 637 B SWEEP CAL (see Figure 5-7-2).
6. In the same way, turn the REPETITION in accordance with the B TIME/DIV switch setting, and check the errors of (I) and (II) for the range from 50 mSEC to 10 SEC.
7. In the same way as step 6, check the errors of (I) and (II) at 5 µSEC and 0.5 µSEC.
8. If out of the rating, adjust the C622 for 5 µSEC, and the C624 for 0.5 µSEC (see Figure 5-7-2 and Table 5-7-2).
9. Push the HF of the PULSE TRAIN of the scope calibrator, and check the errors of (I) and (II) at 20 nSEC and 50 nSEC. At this time, set the 20 nS - 10 nS switch of the scope calibrator to 20 nS. (2.5 pulse/div at 50 nSEC). If out of the rating, adjust the respective adjustment. (See Figure 5-7-2 and Table 5-7-2.)

Table 5-7-2. Adjustment of B sweep rate

B TIME/DIV	Adjustment
1 mSEC	R637 B SWEEP CAL
20 nSEC	R635
50 nSEC	R633
0.1 µSEC to 0.5 µSEC	C624
1 µSEC to 5 µSEC	C622

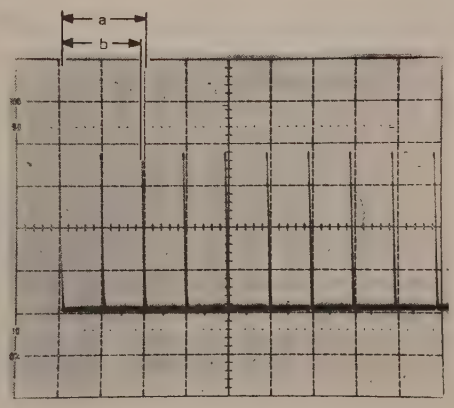
Figure 5-7-3. Sweep Rate Error (I)



$$\text{Error Rate} = \frac{a - b}{a} \times 100\ (\%)$$

a = horizontal effective scale (8 div)
b = the measured value by time marker for a

Figure 5-7-4. Sweep Rate Error (II)



$$\text{Error Rate} = \frac{a - b}{a} \times 100\ (\%)$$

a = any of 2 div on horizontal effective surface
b = the measured value by time marker for a

5-7-6 Magnified Sweep Rate

Ratings:

(I) Accuracy of sweep rate for 8 divisions at the center of the CRT screen:

2 nS/div, 5 nS/div	±4%
10 nS/div to 50 nS/div	±3%

(II) Accuracy of sweep rate for any 2 divisions in 8 divisions at the center of the CRT screen:

2 nS/div, 5 nS/div	±10%
10 nS/div to 50 nS/div	± 6%
0.1 µs/div to 50 mS/div	± 5%

Note:

The above ratings for 2 nS/div to 20 nS/div are effective except the following sweeps from the sweep start point:
15 div for 2 nS/div, 6 div for 5 nS/div, 3 div for 10 nS/div, and 1.5 div for 20 nS/div

Check and Adjustment

1. Succeeding to the checking operation for the previous "Sweep Rate", set the A TIME/DIV switch to 0.1 mSEC, and the REPETITION to 0.1 mSEC, and adjust the start pulse to the left end position of the graticule.
2. Set the A TIME/DIV switch to 1 mSEC, and pull the PULL x 10 MAG FINE. Then, check the error of (I). (See Figure 5-7-3.)
3. If out of the rating, adjust the R 717 x 10 GAIN (see Figure 5-7-1).
4. Check the error of (II). (See Figure 5-7-4.)
5. In the same way, change the REPETITION in accordance with the A TIME/DIV switch, and check the errors of (I) and (II).
6. Push the HF of the PULSE TRAIN of the scope calibrator, and check the errors of (I) and (II) at 10 ns/div to 50 ns/div. At this time, do not forget to set the 20 nS - 10 nS switch of the scope calibrator to 20 nS at 50 ns/div and 20 ns/div, and to 10 nS at 10 ns/div.
7. Remove the scope calibrator, and connect the output of the standard signal generator.
8. Check the errors of (I) and (II) at 2 ns/div and 5 ns/div. Set the repetition frequency to 100 MHz at 5 ns/div, and to 250 MHz at 2 ns/div.

5-7-7 Sweep Start

Check and Adjustment

1. Set the SWEEP MODE switch to AUTO, and the A TIME/DIV switch to 1 mSEC.
2. Set the DISPLAY switch to ALT, the B TIME/DIV switch to 0.5 mSEC, and the B LEVEL control fully counterclockwise to the AUTO.
3. Allow two traces to appear on the CRT screen, and pull the PULL x 10 MAG control and turn the POSITION control clockwise to let the start points of the traces. Check if the two traces start on the same point at this time.
4. If the start points deviate from each other, adjust the R 759 START ADJ (see Figure 5-7-1).

5-7-8 Delay Jitter

Rating: 1/20,000 or less

Check

1. Set the controls as follows:

DISPLAY	DLY'D(B)
A TIME/DIV	1 mSEC
B TIME/DIV	0.5 µSEC
B LEVEL	AUTO (Fully counterclockwise)

2. Apply the output of OUTPUT 2 of the scope calibrator to the CH1 INPUT of the V-810, push the button to the left of the PULSE TRAIN, set the REPETITION to 1 mSEC, and allow the triggering.
3. Turn the DELAY TIME MULTI fully clockwise (around 10.00), and allow the pulse to appear at the center of the CRT screen. Check the jitter is within 1 div.

5-7-9 Delay Time

Rating: Within ±3% at 1 µs/div to 5 s/div

Check and Adjustment

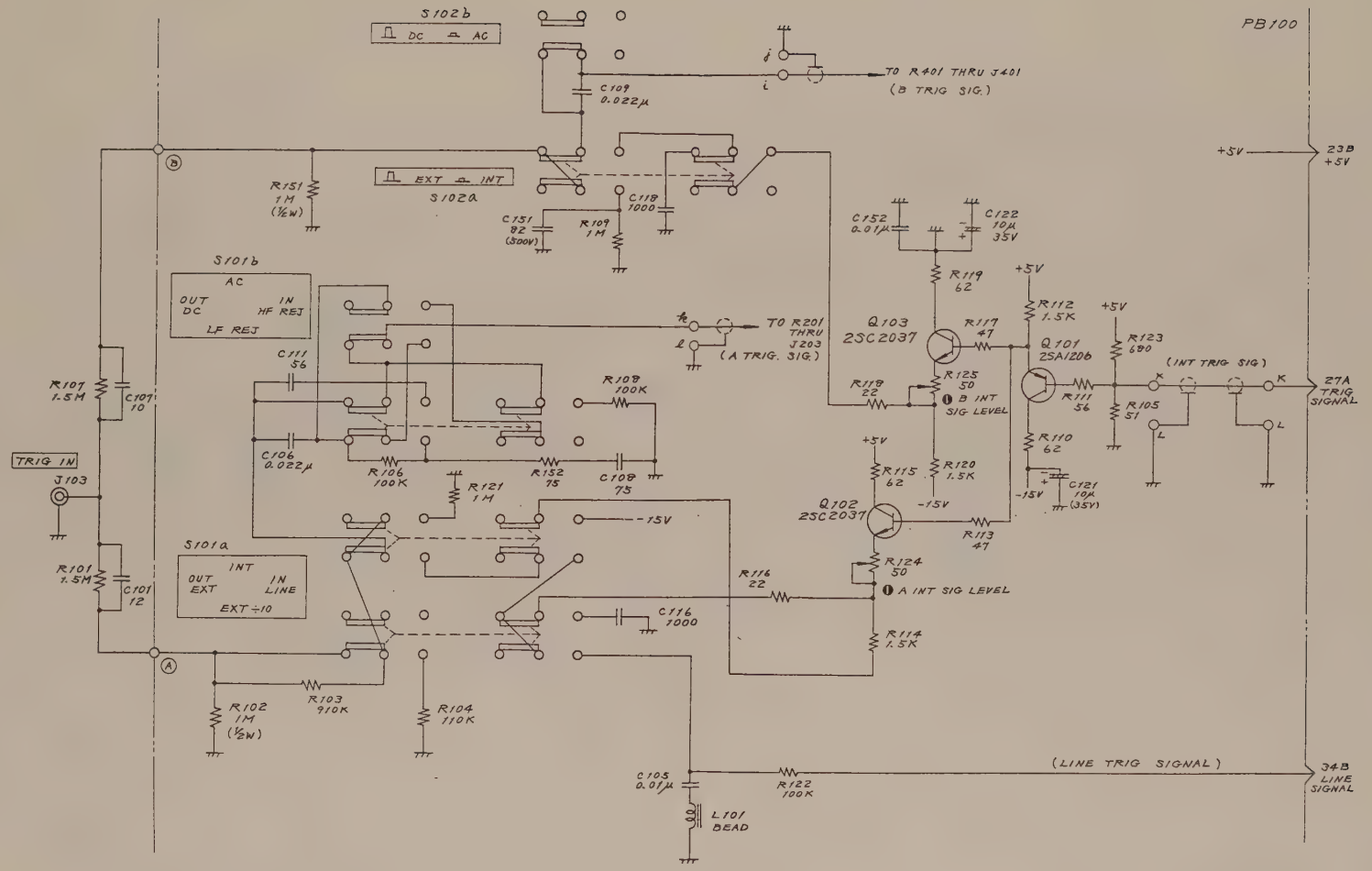
1. Set the controls as follows:

DISPLAY	A INTEN
A TIME	1 mSEC
B TIME	50 µSEC
B LEVEL	AUTO (Fully counterclockwise)

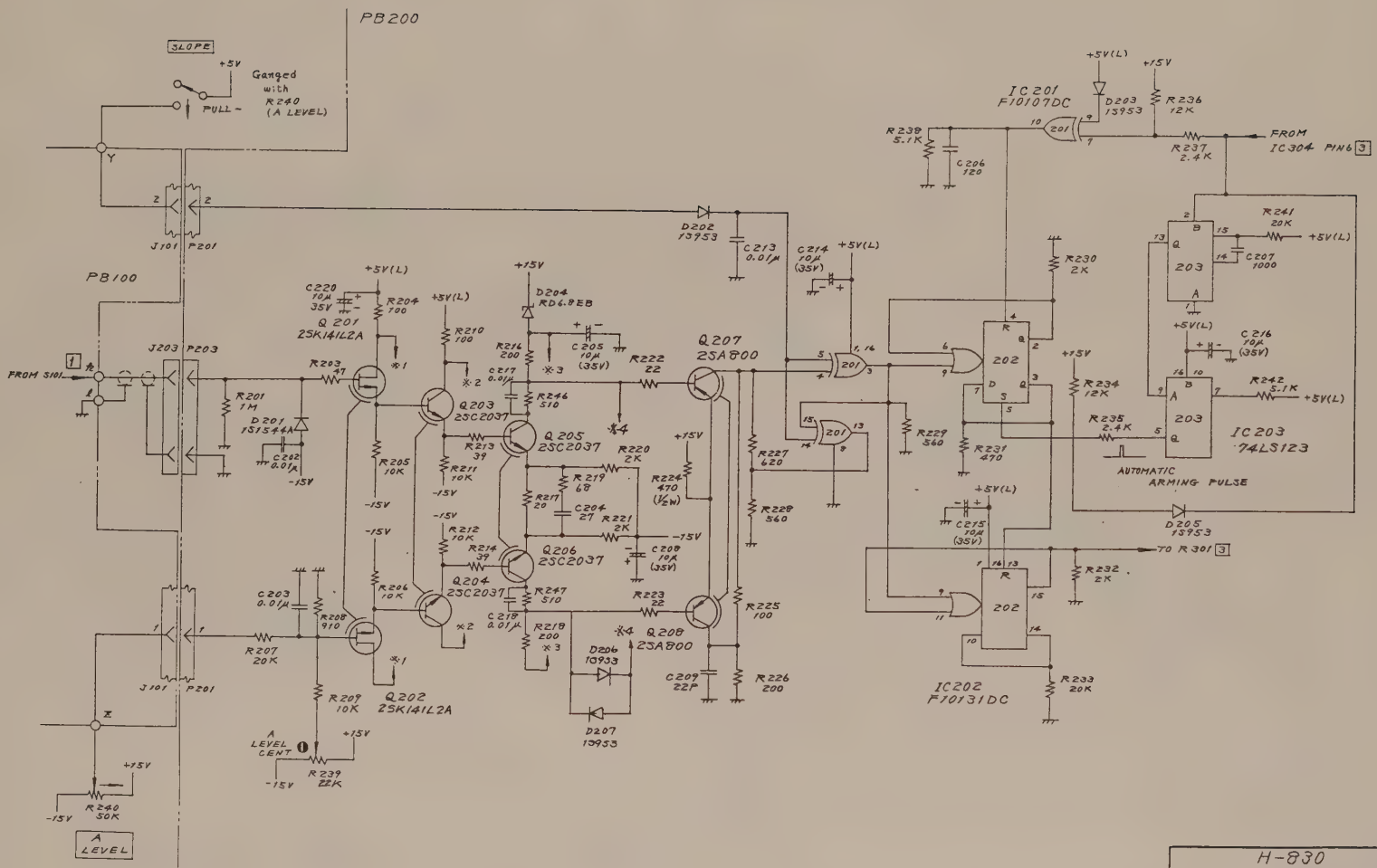
2. Apply the output of OUTPUT 2 of the scope calibrator to the CH1 INPUT of the V-810, push the button to the left of the PULSE TRAIN, set the REPETITION to 1 mSEC, and allow the triggering.
3. Set the start pulse to the left end of the graticule.
4. Turn the DELAY TIME MULTI fully counterclockwise, and check that the dial indicates 0.50.
5. Turn the dial clockwise to let the start point of the intensified part agree with the second pulse from the left end, and check that the dial indicates a value with the range from 0.97 to 1.03.
6. Turning the dial further clockwise, let the start point of the intensified part agree with the 10th pulse. Check that the indicated value of the dial at this time is within 8.97 to 9.03.
7. If out of the rating, set the dial to the position of 1.00, and adjust the R551 DELAY START (see Figure 5-7-2) to set the start point of the intensified part to the second pulse.
8. Then, set the dial to the position of 9.00, and adjust the R549 DELAY STOP so that the starting point of the intensified part agrees with the 10th pulse (see Figure 5-7-2).
9. Repeat the adjustment in steps 7 and 8.

MEMO

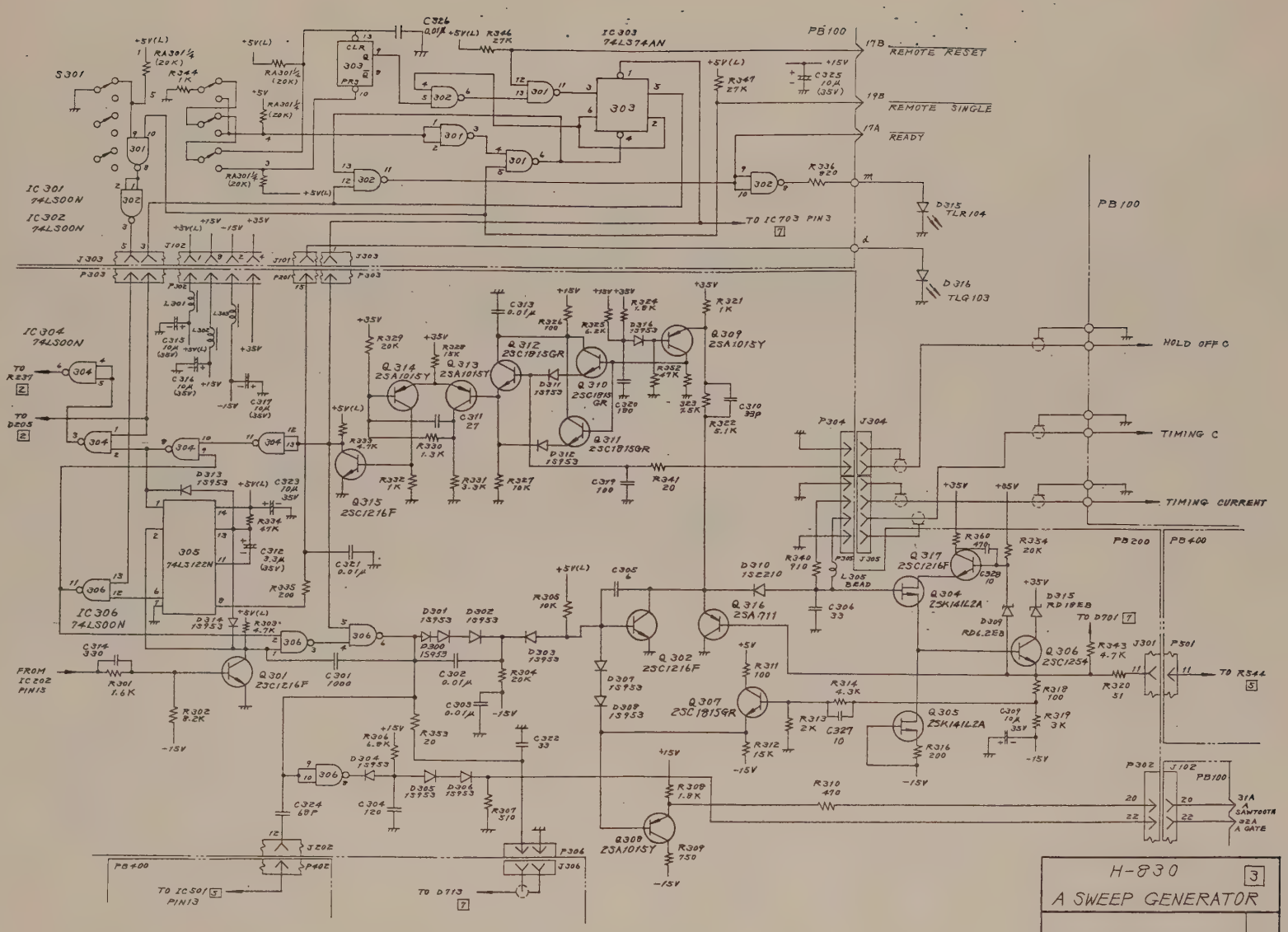
Section 6 Schematic Diagrams



H-830	1
TRIG SIGNAL SWITCHES	
K-606799	1



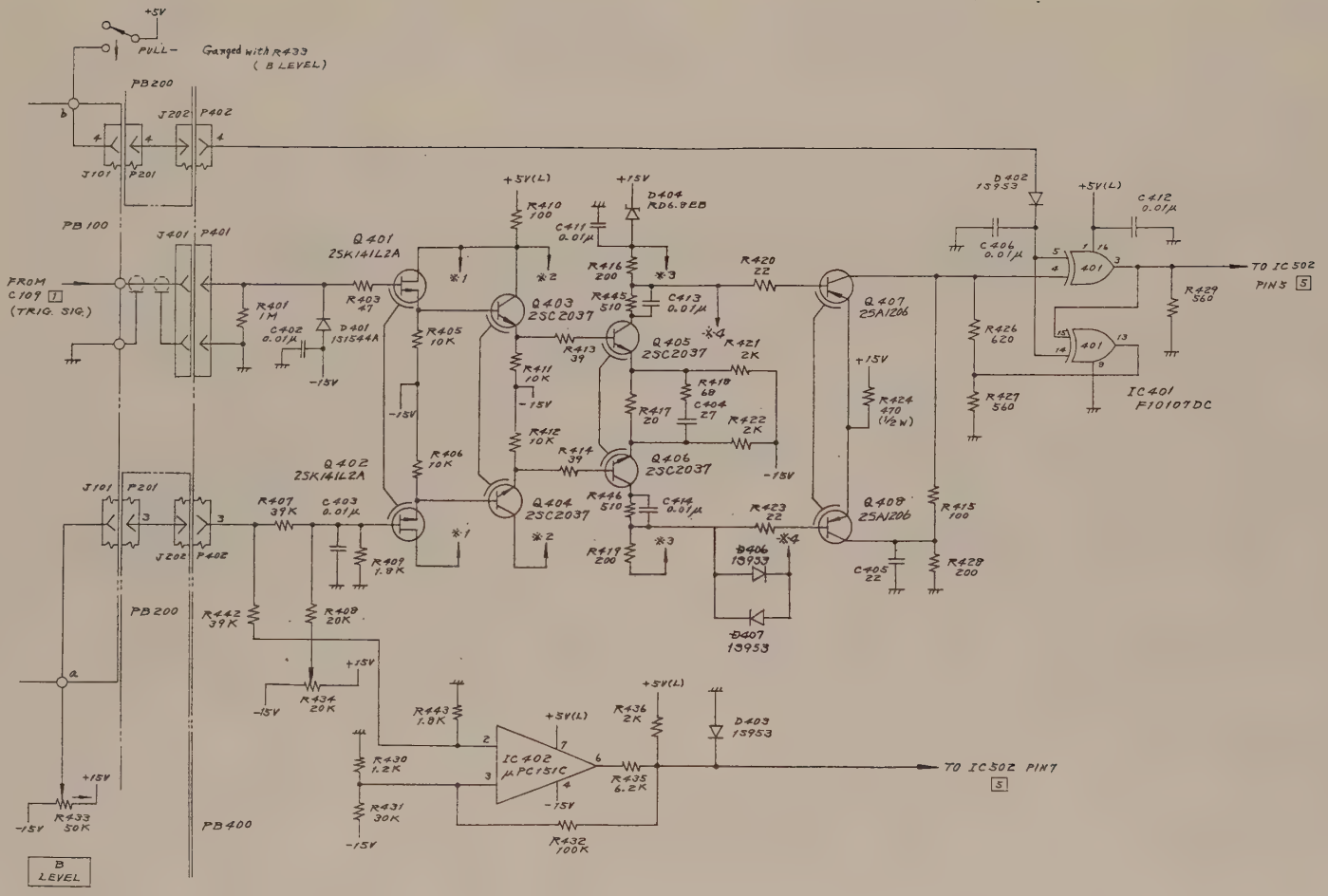
H-830 A TRIGGER GENERATOR	2
K-606800	2



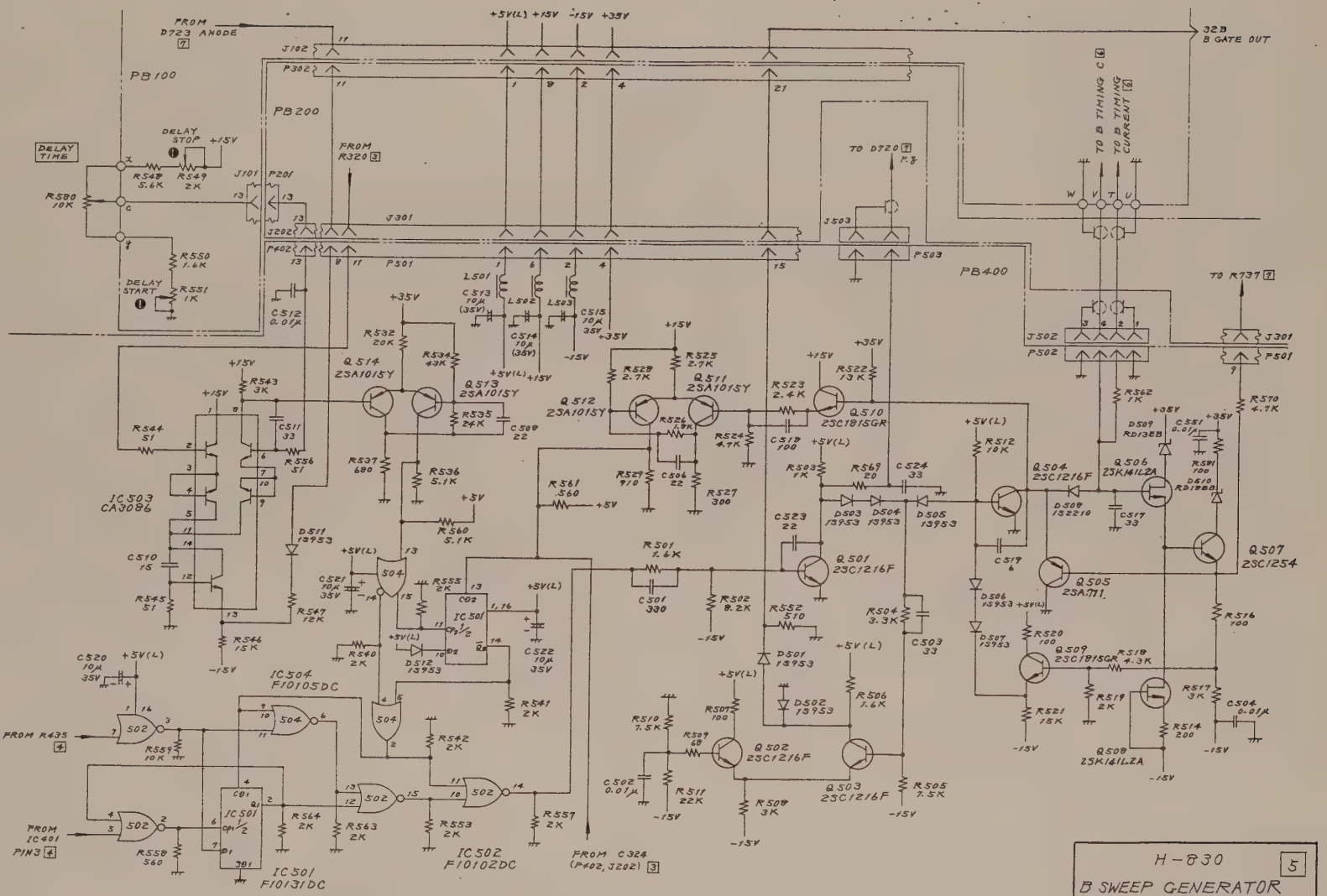
H-830 3

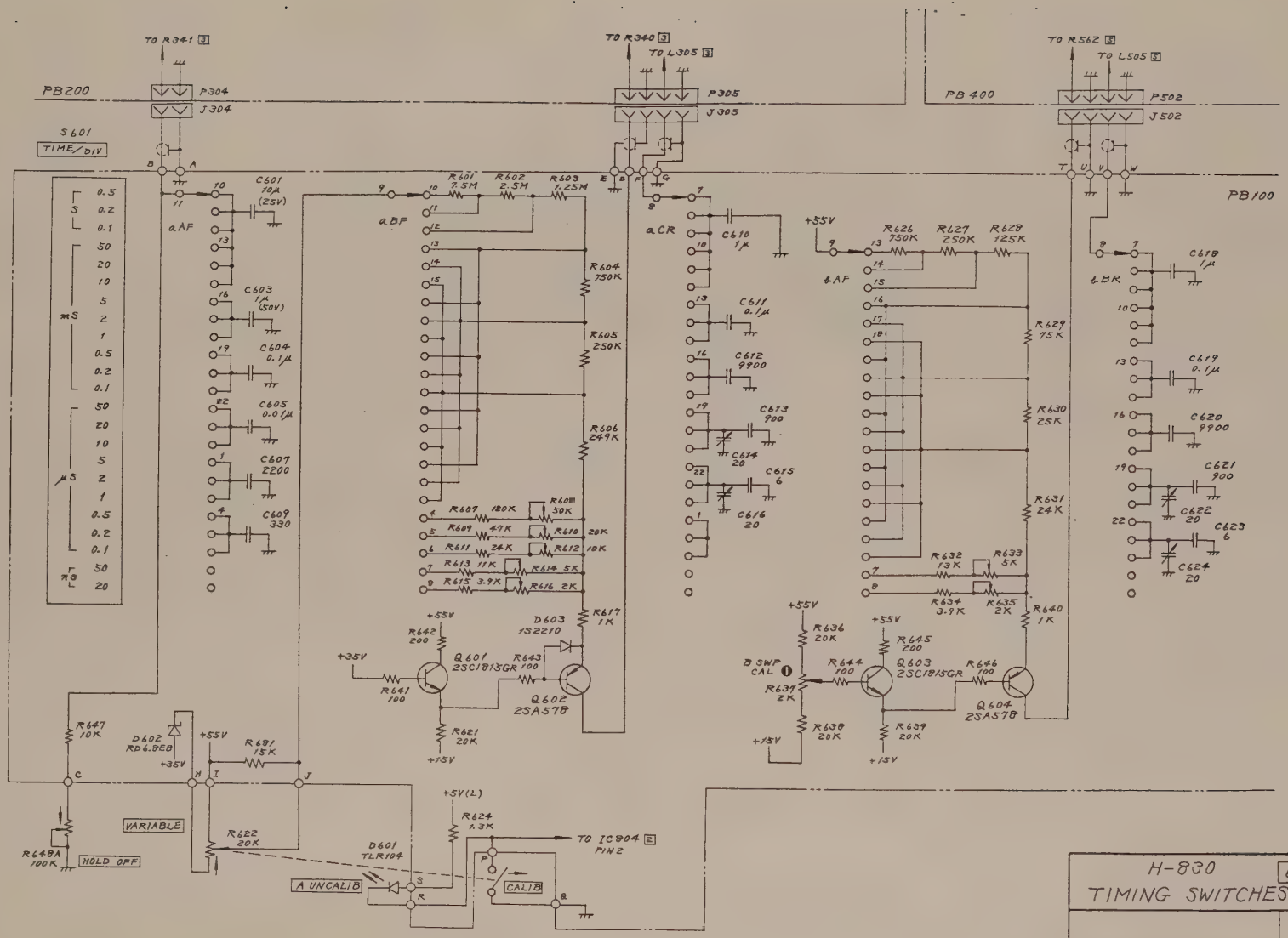
A SWEEP GENERATOR

K-606801 2

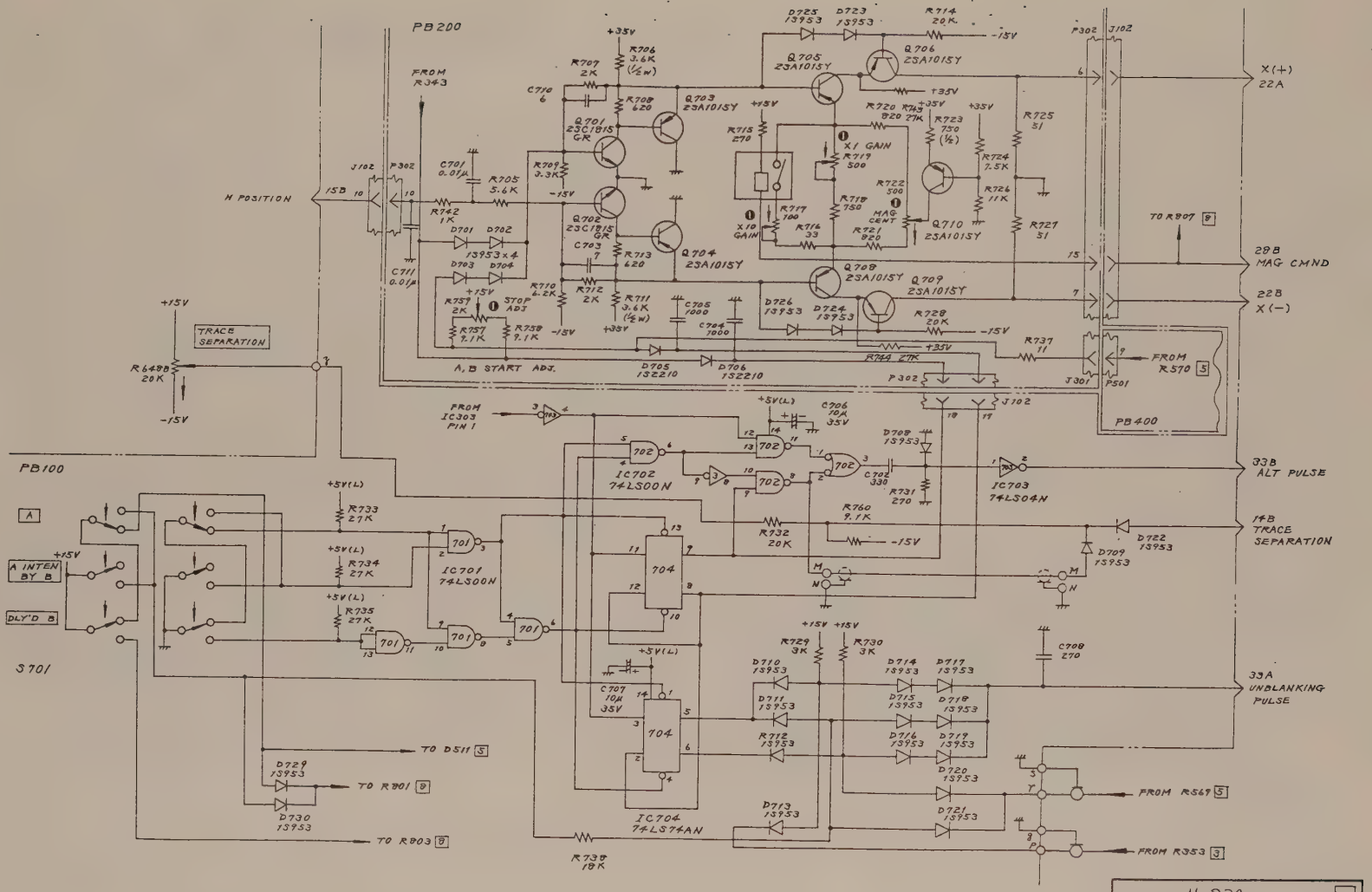


H-830	4
B TRIGGER GENERATOR	
K-606802	2


PB100
PB200
PB400
FROM D723 ANODE 7
FROM R320 3
TO D720 7 P.8
32B B GATE OUT
TO B TIMING C 4
TO B TIMING CURRENT 3
TO R737 7
DELAY TIME
DELAY STOP
DELAY START
R548 5.6K
R549 2K
R550 1.6K
R551 1K
R580 10K
J102
P302
J301
J202
P402
P301
J101
P201
J503
P503
J502
P502
L501
L502
L503
C513 10μ (35V)
C514 10μ (35V)
C515 10μ 35V
C512 0.01μ
IC503 CA3086
IC504 F10105DC
IC501 F10131DC
IC502 F10102DC
Q514 2SA1015Y
Q513 2SA1015Y
Q512 2SA1015Y
Q511 2SA1015Y
Q510 2SC1815GR
Q504 2SC1216F
Q506 2SK141L2A
Q507 2SC1254
Q501 2SC1216F
Q505 2SA771
Q509 2SC1815GR
Q502 2SC1216F
Q503 2SC1216F
Q509 2SK141L2A
D511 1S1953
D512 1S1953
D501 1S1953
D502 1S1953
D503 1S1953
D504 1S1953
D505 1S1953
D506 1S1953
D507 1S1953
D508 1S2210
D509 RD13EB
D510 RD18BB
FROM R435 4
FROM IC401 PIN3 4
FROM C324 (P402, J202) 3
H-830 5
B SWEEP GENERATOR
K-606803 2

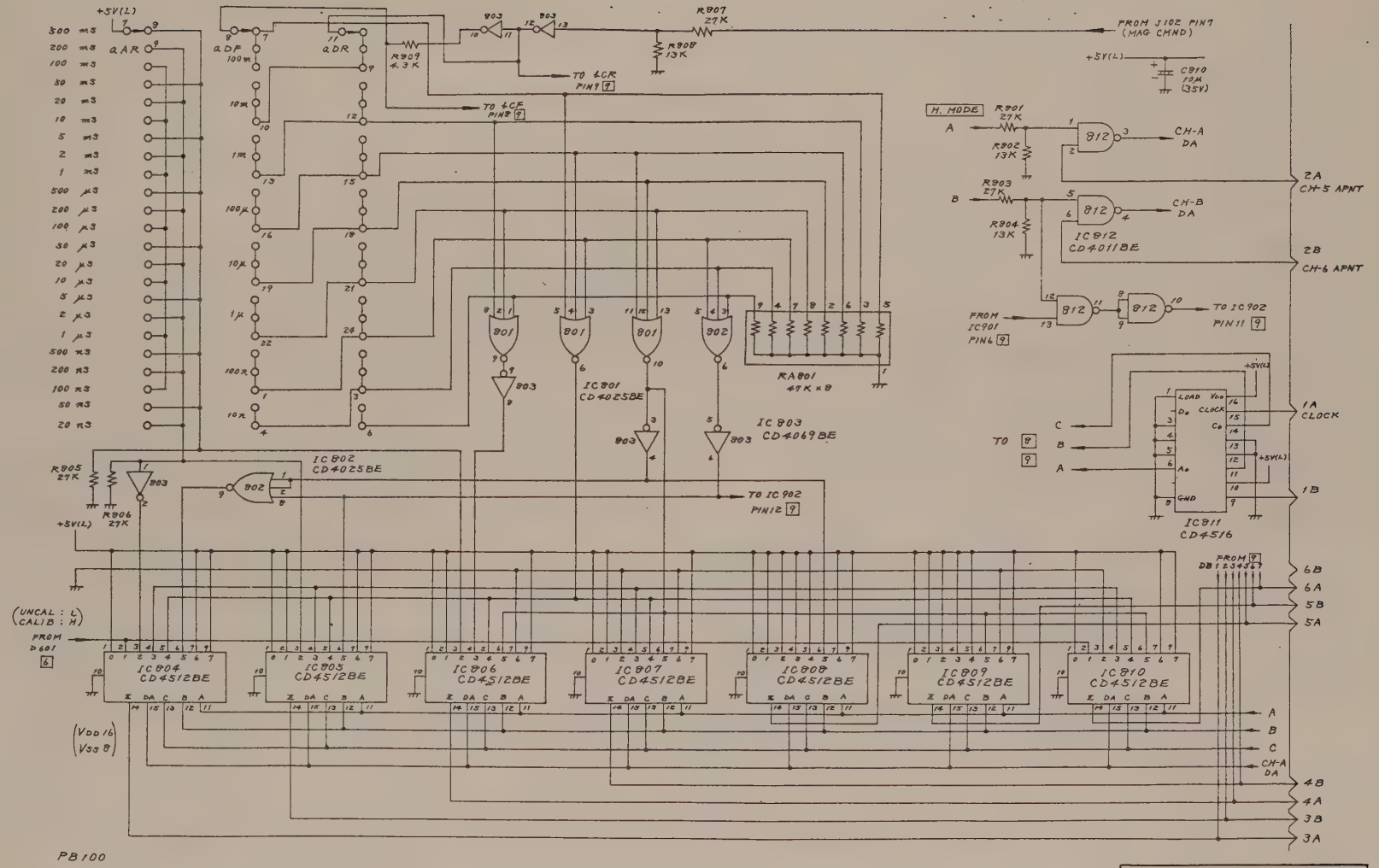


H-830	6
TIMING SWITCHES	
K-606804	1

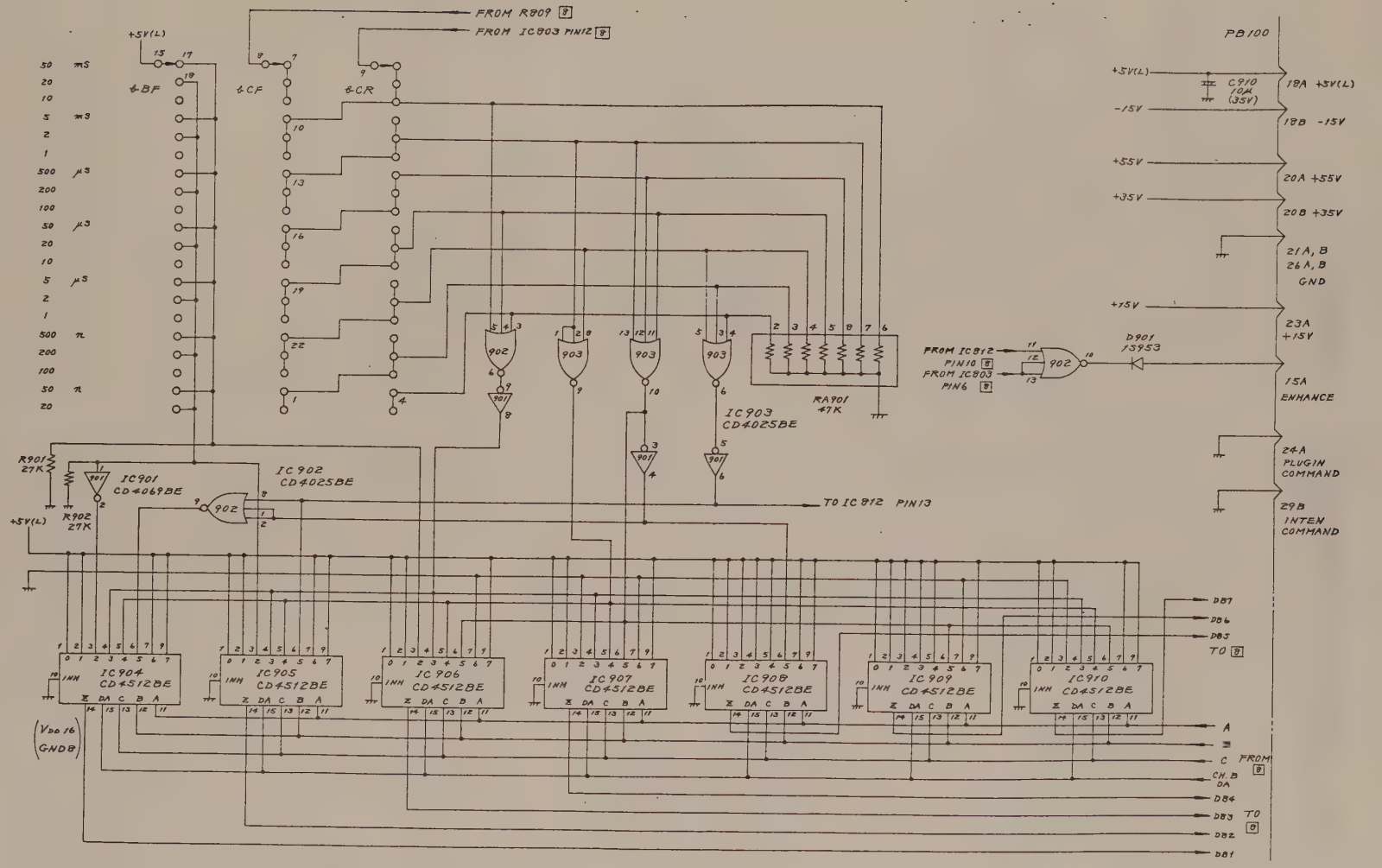


H-830 7
HORIZONTAL DISPLAY CONTROL & HORIZONTAL PREAMPLIFIER

K-606805 1



H-830 A DATA ENCODER	8
K-606806	2



H-830 B DATA ENCODER	9
K-606807	2

Section 7 Electrical Parts List

Ordering Information

Replacement parts may be ordered through an IWATSU Representative or directly from the factory. To be certain of receiving the proper parts, always include the following information with the order:

a. Model number and serial number of the instrument on which the parts will be installed.
b. Circuit reference number and subassembly name, if applicable, for which the part is intended. If the part does not have a circuit reference, the description from the parts list should be used.
c. Iwatsu part number.

For factory repair, contact the IWATSU agent and include the following information.

a. Model number and serial number of the instrument on which the work is to be performed.
b. Details concerning the nature of the malfunction, or type of repair desired.
Shipping instructions will be sent to you promptly.

How To Use This Parts List

The parts list is divided into subsections corresponding to the schematic diagrams. Component locations can be determined from the schematic diagrams, each component appears only once in the parts list. At the beginning of each subsection are listed part numbers for any complete subassemblies, in that category that are available as replacement parts. These subassemblies may include individually-listed components; care should be taken to locate malfunctions to the lowest possible level of replacement part and thus avoid the time and cost involved in "over-repair".

Abbreviations

Cap. ..... Capacitor
Cer. ..... Ceramic
Poly. ..... Polyester film
Elect. ..... Aluminium electrolytic chemical
Elect. tan .. Tantalum electrolytic chemical condenser
[The symbol of F (farad) is omitted]
Res. ..... Resistor
W.W. ..... Wire wound
Comp. ..... Composition
[The symbol of Ω (ohm) is omitted]
FET ..... Field Effect Transistor
Diode .....
T. diode .... Tunnel diode
Z. diode .... Zenner diode
S.B. diode .. Schottky barrier diode
V.C. diode .. Variable capacitance diode
LED ..... Light emission diode
Var. ..... Variable

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
TRIGGER SIGNAL SWITCHES		
C101	Cap., 12p, ±10%, 500V, Cer.	DCC251901
C105	Cap., 0.01μ, ±10%, 50V, Film	DCF120231
C106	Cap., 0.022μ, ±10%, 630V, Film	DCF173271
C107	Cap., 10p, ±0.5p, 500V, Cer.	DCC251701
C108	Cap., 75p, ±5%, 500V, Cer.	DCC253701
C109	Same as C106	
C111	Cap., 56p, ±10%, 500V, Cer.	DCC253401
C116	Cap., 1000p, +80 to -20%, 50V,Cer.	DCC131911
C118	Same as C116	
C121	Cap., 10μ, ±20%, 35V, Elect.	DCS471301
C122	Same as C121	
C151	Cap., 82p, ±10%, 500V, Cer.	DCC253801
C152	Cap., 0.01μ, +80 to -20%, 50V,Cer.	DCC133571
L101	Ferrite Bead, L82-OP-03-03-1H	DCL320251
R101	Res., 1.5M, ±2%, 1/2W, Carbon	DRD341591
R102	Res., 1M, ±1%, 1/2W, Metal	DRE144451
R103	Res., 910k, ±1%, 1/2W, Metal	DRE144441
R104	Res., 110k, ±2%, 1/4W, Metal	DRE134221
R105	Res., 51, ±1%, 1/4W, Metal	DRE535181
R106	Res., 100k, ±2%, 1/4W, Metal	DRE134211
R107	Same as R101	
R108	Same as R106	
R109	Same as R102	
R110	Res., 62, ±1%, 1/4W, Metal	DRE535201
R111	Res., 56, ±1%, 1/4W, Metal	DRE535191
R112	Res., 1.5k, ±1%, 1/4W, Metal	DRE535531
R113	Res., 47, ±1%, 1/4W, Metal	DRE535171
R114	Same as R112	
R115	Same as R110	
R116	Res., 22, ±1%, 1/4W, Metal	DRE535091
R117	Same as R113	
R118	Same as R116	
R119	Same as R110	
R120	Same as R112	
R121	Same as R102	
R122	Res., 100k, ±1%, 1/4W, Metal	DRE535231
R123	Res., 68, ±1%, 1/4W, Metal	DRE535451
R124	Res., 50, Var., 0.5W, Cermet	DRV410131
R125	Same as R124	
R151	Same as R102	
R152	Res., 75, ±1%, 1/4W, Metal	DRE535221
Q101	Transistor, 2SA1206	DTR115301
Q102	Transistor, 2SC2037	DTR137591
Q103	Same as Q102	
S101	Switch, KSD4-14-10 LLDC	DSW013723
S104	Switch, KSD2-6-10 1LLDC	DSW013973
J103	Connector, BNC-BR	DCN040111

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
A TRIGGER GENERATOR		
C202	Cap., 0.01μ, +80 to -20%, 50V, Cer.	DCC133571
C203	Same as C202	
C204	Cap., 27p, ±10%, 50V, Cer.	DCC232601
C205	Cap., 10μ, ±20%, 35V, Elect.	DCS471301
C206	Cap., 120p, ±10%, 50V, Cer.	DCC234101
C207	Cap., 1000p, ±10%, 50V, Film	DCF120111
C208	Same as C205	
C209	Cap., 22p, ±10%, 50V, Cer.	DCC232401
C213	Same as C202	
C214	Same as C205	
C215	Same as C205	
C216	Same as C205	
C217	Same as C202	
C218	Same as C202	
C220	Same as C214	
R201	Res., 1M, ±2%, 1/2W, Metal	DRE144451
R203	Res., 47, ±5%, 1/4W, Carbon	DRD134511
R204	Res., 100, ±5%, 1/4W, Carbon	DRD134591
R205	Res., 100, ±2%, 1/4W, Metal	DRE133971
R206	Same as R205	
R207	Res., 20k, ±2%, 1/4W, Metal	DRE134041
R208	Res., 910, ±2%, 1/4W, Metal	DRE133721
R209	Same as R205	
R210	Same as R204	
R211	Same as R205	
R212	Same as R205	
R213	Res., 39, ±5%, 1/4W, Carbon	DRD134491
R214	Same as R213	
R216	Res., 200, ±1%, 1/4W, Metal	DRE535321
R217	Res., 20, ±1%, 1/4W, Metal	DRE535081
R218	Same as R216	
R219	Res., 68, ±1%, 1/4W, Metal	DRE535211
R220	Res., 2k, ±2%, 1/4W, Metal	DRE133801
R221	Same as R220	
R222	Res., 22, ±1%, 1/4W, Metal	DRE535091
R223	Same as R222	
R224	Res., 470, ±2%, 1/2W, Metal	DRE143651
R225	Res., 100, ±2%, 1/4W, Metal	DRE133491
R226	Res., 200, ±2%, 1/4W, Metal	DRE133561
R227	Res., 620, ±2%, 1/4W, Metal	DRE133681
R228	Res., 560, ±5%, 1/4W, Carbon	DRD134771
R229	Res., 560, ±1%, 1/4W, Metal	DRE535431
R230	Res., 2k, ±1%, 1/4W, Metal	DRE535561
R231	Res., 470, ±1%, 1/4W, Metal	DRE535411
R232	Res., 2k, ±5%, 1/4W, Carbon	DRD134901
R233	Res., 20k, ±1%, 1/4W, Metal	DRE535801
R234	Res., 12k, ±1%, 1/4W, Metal	DRE535751
R235	Res., 2.4k, ±1%, 1/4W, Metal	DRE535581
R236	Same as R234	
R237	Same as R235	
R238	Res., 5.1k, ±1%, 1/4W, Metal	DRE535661

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
R239	Res., 22k, Var., 0.2W, Cermet	DRV430701
R240	Res., 50k, Var., 0.5W, Carbon	DRV146131
R241	Same as R233	
R242	Res., 5.1k, ±5%, 1/4W, Carbon	DRD135001
R246	Res., 510, ±1%, 1/4W, Metal	DRE535421
R247	Same as R246	
D201	Diode, 1S1544A	DDD010801
D202	Diode, 1S953	DDD010051
D203	Same as D202	
D204	Z. Diode, RD6.8EB	DDD032961
D205	Same as D202	
D206	Same as D202	
D207	Same as D202	
Q201	F.E.T, 2SK14/L2A	DTR215321
Q202	Same as Q201	
Q203	Trnasistor, 2SC2037	DTR137591
Q204	Same as Q203	
Q205	Same as Q203	
Q206	Same as Q203	
Q207	Transistor, 2SA800	DTR115701
Q208	Same as Q207	
IC210	IC, F10107DC	DIC310051
IC202	IC, F10131DC	DIC310081
IC203	IC, SN74LS123N	DIC141181
J201	Connector, U-SA1501	DCN031171
J202	Same as J201	
J203	Connector, M36M87-02	DCN034601
P201	Connector, U-PA1521	DCN031141
P203	Connector, M36-02-30-134P	DCN034901

A SWEEP GENERATOR

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
C301	Cap., 1000p, ±10%, 50V, Film	DCF120111
C302	Cap., 0.01μ, +80 to -20%,50V,Cer.	DCC133571
C303	Same as C302	
C304	Cap., 120p, ±10%, 50V, Cer.	DCC234101
C305	Cap., 6p, ±0.5p, 50V, Cer.	DCC231001
C306	Cap., 33p, ±5%, 300V, Elect.	DCM252511
C309	Cap., 10μ, ±20%, 35V, Elect.	DCS471301
C311	Cap., 27p, ±10%, 50V, Cer.	DCC232601
C312	Cap., 3.3μ, ±10%, 35V, Elect.	DCE230361
C313	Same as C302	
C314	Cap., 330p, ±10%, 50V, Cer.	DCC234901
C315	Same as C309	
C316	Same as C309	
C317	Same as C309	
C319	Cap., 100p, ±10%, 50V, Cer.	DCC234001
C320	Cap., 180p, ±10%, 50V, Cer.	DCC234301
C321	Same as C302	
C322	Cap., 33p, ±5%, 50V, Cer.	DCC232801
C323	Same as C309	
C324	Cap., 68p, ±10%, 50V, Cer.	DCC233601
C325	Cap., 10μ, ±20%, 35V, Elect.	DCS471301
C326	Cap., 0.01μ, +80 to -20%,50V, Cer.	DCC133571
C327	Cap., 10p, ±0.5p, 50V, Cer.	DCC231701
C328	Same as C327	
L301	Coil, A	DCL150561
L302	Same as L301	
L303	Same as L301	
L305	Ferrite Bead, L82-0P-03-03-1H	DCL320251
R301	Res., 1.6k, ±1%, 1/4W, Metal	DRE535541
R302	Res., 8.2k, ±1%, 1/4W, Metal	DRE535711
R303	Res., 4.7k, ±1%, 1/4W, Metal	DRE535651
R304	Res., 20k, ±5%, 1/4W, Carbon	DRD135141
R305	Res., 10k, ±5%, 1/4W, Carbon	DRD135071
R306	Res., 6.2k, ±5%, 1/4W, Carbon	DRD135021
R307	Res., 510k, ±5%, 1/4W, Carbon	DRD134761
R308	Res., 1.8k, ±5%, 1/4W, Carbon	DRD134891
R309	Res., 750, ±5%, 1/4W, Carbon	DRD134801
R310	Res., 470, ±5%, 1/4W, Carbon	DRD134751
R311	Res., 100, ±5%, 1/4W, Carbon	DRD134591
R312	Res., 15k, ±5%, 1/4W, Carbon	DRD135111
R313	Res., 2k, ±5%, 1/4W, Carbon	DRD134901
R314	Res., 4.3k, ±5%, 1/4W, Carbon	DRD134981
R316	Res., 200, ±1%, 1/4W, Metal	DRE535321
R318	Res., 100, ±2%, 1/4W, Metal	DRE133491
R319	Res., 3k, ±2%, 1/4W, Metal	DRE133841
R320	Res., 51, ±5%, 1/4W, Carbon	DRD134521

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
R321	Res., 1k, ±2%, 1/4W, Metal	DRE133731
R322	Res., 5.1k, ±2%, 1/4W, Metal	DRE133901
R323	Res., 7.5k, ±1%, 1/4W, Metal	DRE535701
R324	Res., 1.8k, ±2%, 1/4W, Metal	DRE133791
R325	Res., 6.2k, ±2%, 1/4W, Metal	DRE133921
R326	Same as R311	
R327	Res., 10k, ±2%, 1/4W, Metal	DRE133971
R328	Res., 15k, ±2%, 1/4W, Metal	DRE134011
R329	Res., 20k, ±2%, 1/4W, Metal	DRE134041
R330	Res., 1.3k, ±2%, 1/4W, Metal	DRE133761
R331	Res., 3.3k, ±2%, 1/4W, Metal	DRE133851
R332	Res., 1k, ±5%, 1/4W, Carbon	DRD134831
R333	Res., 4.7k, ±5%, 1/4W, Carbon	DRD134991
R334	Res., 47k, ±1%, 1/4W, Metal	DRE535291
R335	Res., 200, ±1%, 1/4W, Metal	DRE535321
R336	Res., 820, ±1%, 1/4W, Metal	DRE535471
R340	Res., 910, ±5%, 1/4W, Carbon	DRD134821
R341	Res., 20, ±5%, 1/4W, Carbon	DRD134421
R343	Res., 4.7k, ±2%, 1/4W, Metal	DRE133891
R344	Res., 1k, ±1%, 1/4W, Metal	DRE535491
R346	Res., 27k, ±1%, 1/4W, Metal	DRE535831
R347	Same as R346	
R352	Res., 47k, ±2%, 1/4W, Metal	DRE134131
R353	Same as R341	
R354	Same as R304	
R360	Res., 470, ±1%, 1/4W, Metal	DRE535411
RA301	Resistor Array, 4-18kΩ	DFB016111
D300	Diode, 1S953	DDD010051
D301	Same as D300	
D302	Same as D300	
D303	Same as D300	
D304	Same as D300	
D305	Same as D300	
D306	Same as D300	
D307	Same as D300	
D308	Same as D300	
D309	Z. Diode, DR6.2EB	DDD030611
D310	Diode, 1S2210	DDD010351
D311	Same as D300	
D312	Same as D300	
D313	Same as D300	
D314	Same as D300	
D315	Z, Diode, RD18EB	DDD033531
D315A	Diode, TLR104	DDD070301
D316	Same as D300	
D316A	Diode, TLG103	DDD070841

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
Q301	Transistor, 2SC1216F	DTR130801
Q302	Same as Q301	
Q304	F.E.T. 2SK14/L2A	DTR215321
Q305	Same as Q304	
Q306	Transistor, 2SC1254	DTR130861
Q307	Transistor, 2SC1815GR	DTR137781
Q308	Transistor, 2SA1015Y	DTR116111
Q309	Same as Q308	
Q310	Same as Q307	
Q311	Same as Q307	
Q312	Same as Q307	
Q313	Same as Q308	
Q314	Same as Q308	
Q315	Same as Q301	
Q316	Transistor, 2SA711	DTR110551
Q317	Same as Q301	
IC301	IC, SN74LS00N	DIC140011
IC302	Same as IC301	
IC303	IC, SN74LS74AN	DIC140751
IC304	Same as IC301	
IC305	IC, SN74LS122N	DIC141171
IC306	Same as IC301	
S301	Switch, KSD-3-6-10MLDC	DSW013731
J301	Connector, U-SA1501	DCN031171
J302	Connector, U-SA2201	DCN031231
J303	Connector, U-SA0501	DCN031051
J304	Connector, M36M87-02	DCN034601
J305	Connector, M36M87-04	DCN034621
J306	Same as J305	
P302	Connector, U-PA2221	DCN031201
P303	Connector, U-PA0521	DCN031021
P304	Connector, M36-02-30-134P	DCN034901
P305	Connector, M36-04-30-134P	DCN034921
P306	Same as P304	

B TRIGGER GENERATOR

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
C402	Cap., 0.01μ, +80 to -20%,50V, Cer.	DCC133571
C403	Same as C402	
C404	Cap., 27p, ±10%, 50V, Cer.	DCC232601
C405	Cap., 22p, ±10%, 50V, Cer.	DCC232401
C406	Same as C402	
C411	Same as C402	
C412	Same as C402	
C413	Same as C402	
C414	Same as C402	
R401	Res., 1M, ±2%, 1/2W, Metal	DRE144451
R403	Res., 47, ±5%, 1/4W, Carbon	DRD134511
R405	Res., 10k, ±1%, 1/4W, Metal	DRE535731
R406	Same as R405	
R407	Res., 39k, ±2%, 1/4W, Metal	DRE134111
R408	Res., 20k, ±2%, 1/4W, Metal	DRE134041
R409	Res., 1.8k, ±2%, 1/4W, Metal	DRE133791
R410	Res., 100, ±5%, 1/4W, Carbon	DRD134591
R411	Same as R405	
R412	Same as R405	
R413	Res., 39, ±1%, 1/4W, Metal	DRE535151
R414	Same as R413	
R415	Res., 100, ±2%, 1/4W, Metal	DRE133491
R416	Res., 200, ±1%, 1/4W, Metal	DRE535321
R417	Res., 20, ±1%, 1/4W, Metal	DRE535081
R418	Res., 68, ±1%, 1/4W, Metal	DRE535211
R419	Same as R416	
R420	Res., 22, ±1%, 1/4W, Metal	DRE535091
R421	Res., 2k, ±1%, 1/4W, Metal	DRE535561
R422	Same as R421	
R423	Same as R420	
R424	Res., 470, ±2%, 1/2W, Metal	DRE143651
R426	Res., 620, ±2%, 1/4W, Metal	DRE133681
R427	Res., 560, ±5%, 1/4W, Carbon	DRD134771
R428	Res., 200, ±2%, 1/4W, Metal	DRE133561
R429	Same as R427	
R430	Res., 1.2k, ±5%, 1/4W, Carbon	DRD134851
R431	Res., 30k, ±5%, 1/4W, Carbon	DRD135181
R432	Res., 100k, ±5%, 1/4W, Carbon	DRD135311
R433	Res., 50k, Var., 1/2W, Carbon	DRV146131
R434	Res., 20k, Var., 1/2W, Cermet	DRV410211
R435	Res., 6.2k, ±5%, 1/4W, Carbon	DRD135021
R436	Res., 2k, ±5%, 1/4W, Carbon	DRD134901
R442	Same as R407	
R443	Same as R409	
R445	Res., 510, ±1%, 1/4W, Metal	DRE535421
R446	Same as R445	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
D401	Diode, 1S1544A	DDD010801
D402	Diode, 1S953	DDD010051
D403	Same as D402	
D404	Z. Diode, RD6.8EB	DDD032961
D406	Same as D402	
D407	Same as D402	
Q401	F.E.T. 2SK14/L2A	DTR215321
Q402	Same as Q401	
Q403	Transistor, 2SC2037	DTR137591
Q404	Same as Q403	
Q405	Same as Q403	
Q406	Same as Q403	
Q407	Transistor, 2SA1206	DTR115301
Q408	Same as Q407	
IC401	IC, F10107DC	DIC310051
IC402	IC, μPC151C	DIC610021
J401	Connector, M36M87-02	DCN034601
P401	Connector, M36-02-30-134P	DCN034901
P402	Connector, U-PA1556	DCN031381

B SWEEP GENERATOR

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
C501	Cap., 330p, ±10%, 50V, Cer.	DCC234901
C502	Cap., 0.01μ, +80 to -20%, 50V, Cer.	DCC133571
C503	Cap., 33p, ±10%, 50V, Cer.	DCC232801
C504	Same as C502	
C506	Cap., 22p, ±10%, 50V, Cer.	DCC232401
C508	Same as C506	
C510	Cap., 15p, ±10%, 50V, Cer.	DCC232001
C511	Same as C503	
C512	Same as C502	
C513	Cap., 10μ, ±20%, 35V, Elect.	DCS471301
C514	Same as C513	
C515	Same as C513	
C517	Cap., 33p, ±5%, 300V, Mica	DCM252511
C518	Cap., 100p, ±10%, 50V, Cer.	DCC234001
C519	Cap., 6p, ±0.5p, 50V, Cer.	DCC231001
C520	Same as C513	
C521	Same as C513	
C522	Same as C513	
C523	Same as C506	
C524	Same as C503	
C551	Same as C502	
L501	Coil, A	DCL150561
L502	Same as L501	
L503	Same as L501	
R501	Res., 1.6k, ±2%, 1/4W, Metal	DRE133781
R502	Res., 8.2k, ±2%, 1/4W, Metal	DRE133951
R503	Res., 1k, ±5%, 1/4W, Carbon	DRD134831
R504	Res., 3.3k, ±2%, 1/4W, Metal	DRE133851
R505	Res., 7.5k, ±2%, 1/4W, Metal	DRE133941
R506	Res., 1.6k, ±5%, 1/4W, Carbon	DRD134881
R507	Res., 100, ±5%, 1/4W, Carbon	DRD134591
R508	Res., 3k, ±2%, 1/4W, Metal	DRE133841
R509	Res., 68k, ±5%, 1/4W, Carbon	DRD134551
R510	Same as R505	
R511	Res., 22k, ±2%, 1/4W, Metal	DRE134051
R512	Res., 10k, ±5%, 1/4W, Carbon	DRD135071
R514	Res., 200, ±2%, 1/4W, Metal	DRE133561
R516	Res., 100, ±2%, 1/4W, Metal	DRE133491
R517	Res., 3k, ±2%, 1/4W, Metal	DRE133841
R518	Res., 4.3k, ±2%, 1/4W, Metal	DRE133881
R519	Res., 2k, ±2%, 1/4W, Metal	DRE133801
R520	Res., 100, ±5%, 1/4W, Carbon	DRD134591
R521	Res., 15k, ±2%, 1/4W, Metal	DRE134011
R522	Res., 13k, ±2%, 1/4W, Metal	DRE134001
R523	Res., 2.4k, ±2%, 1/4W, Metal	DRE133821
R524	Res., 4.7k, ±2%, 1/4W, Metal	DRE133891
R525	Res., 2.7k, ±2%, 1/4W, Metal	DRE133831
R526	Res., 1.8k, ±2%, 1/4W, Metal	DRE133791
R527	Res., 300, ±2%, 1/4W, Metal	DRE133601
R528	Same as R525	
R529	Res., 910, ±5%, 1/4W, Carbon	DRE134821
R532	Res., 20k, ±2%, 1/4W, Metal	DRE134041
R534	Res., 43k, ±2%, Metal	DRE134121
R535	Res., 24k, ±2%, 1/4W, Metal	DRE134061
R536	Res., 5.1k, ±5%, 1/4W, Carbon	DRD135001
R537	Res., 680, ±2%, 1/4W, Metal	DRE133691
R540	Res., 2k, ±1%, 1/4W, Metal	DRE535561
R541	Same as R541	
R542	Same as R541	
R543	Res., 3k, ±5%, 1/4W, Carbon	DRD134941
R544	Res., 51, ±5%, 1/4W, Carbon	DRD134521
R545	Same as R544	
R546	Res., 15k, ±5%, 1/4W, Carbon	DRD135111
R547	Res., 12k, ±5%, 1/4W, Carbon	DRD135091
R548	Res., 5.6k, ±1%, 1/4W, Metal	DRE535671
R549	Res., 2k, Var., 0.5W, Cermet	DRV410011
R550	Res., 1.6k, ±1%, 1/4W, Metal	DRE535541
R551	Res., 1k, Var., 0.5W, Cermet	DRV410171
R552	Res., 510, ±5%, 1/4W, Carbon	DRD134761
R553	Same as R540	
R555	Same as R540	
R556	Same as R544	
R557	Res., 2k, ±5%, 1/4W, Carbon	DRD134901
R558	Res., 560, ±1%, 1/4W, Metal	DRE535431
R559	Res., 10k, ±1%, 1/4W, Metal	DRE535731
R560	Same as R536	
R561	Res., 560, ±5%, 1/4W, Carbon	DRD134771
R562	Res., 1K, ±1%, 1/4W, Metal	DRE535491
R563	Same as R540	
R564	Same as R540	
R569	Res., 20, ±5%, 1/4W, Carbon	DRD134421
R570	Res., 4.7k, ±1%, 1/4W, Metal	DRE535651
R580	Res., 10k, Var., 1.5W, W.W.	DRV770351
R581	Res., 100, ±1%, 1/4W, Metal	DRE535251
D501	Diode, 1S953	DDD010051
D502	Same as D501	
D503	Same as D501	
D504	Same as D501	
D505	Same as D501	
D506	Same as D501	
D507	Same as D501	
D508	Diode, 1S2210	DDD010351
D509	Z. Diode, RD13EB	DDD033521
D510	Z. Diode, RD18EB	DDD033531
D511	Same as D501	
D512	Same as D501	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
Q501	Transistor, 2SC1216F	DTR130801
Q502	Same as Q501	
Q503	Same as Q501	
Q504	Same as Q501	
Q505	Transistor, 2SA711	DTR110551
Q506	F.E.T. 2SK14/L2A	DTR215321
Q507	Transistor, 2SC1254	DTR130861
Q508	Same as Q506	
Q509	Transistor, 2SC1815GR	DTR137781
Q510	Same as Q509	
Q511	Transistor, 2SA1015Y	DTR116111
Q512	Same as Q511	
Q513	Same as Q511	
Q514	Same as Q511	
IC501	IC, F10131DC	DIC310081
IC502	IC, F10102DC	DIC310021
IC503	IC, CA3086	DIC190381
IC504	IC, F10105DC	DIC310041
J502	Connector, M36M87-04	DCN034621
J503	Connector, M36M87-02	DCN034601
P501	Connector, U-PA 1556	DCN031381
P502	Connector, M36-04-30-134P	DCN034921
P503	Connector, M36-02-30-134P	DCN034901

TIMING SWITCHES

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
C601	Cap., 10μ, ±10%, 25V, Elect.	DCE122511
C603	Cap., 1μ, ±10%, 50V, Elect.	DCE140261
C604	Cap., 0.1μ, ±10%, 50V, Film	DCF120351
C605	Cap., 0.01μ, ±10%, 50V, Film	DCF120231
C607	Cap., 0.022μ, ±10%, 50V, Film	DCF120151
C609	Cap., 330p, ±10%, 50V, Cer.	DCC234901
C610	Cap., 1μ, ±0.25p, 50V, Film	DCF420281
C611	Cap., 0.1μ, ±0.25p, 50V, Film	DCF420271
C612	Cap., 9900p, ±0.25p, 50V, Film	DCF125791
C612A	Cap., 82p, ±5%, 50V, Cer.	DCC233801
C613	Cap., 900p, ±0.25p, 50V, Film	DCF125801
C614	Cap., 6.6μ to 20p, Var., 500V, Cer.	DCV011141
C615	Cap., 6p, ±0.5p, 50V, Cer.	DCC231001
C616	Same as C614	
C618	Same as C610	
C619	Same as C611	
C620	Same as C612	
C620A	Same as C612A	
C621	Same as C613	
C622	Same as C614	
C623	Same as C615	
C624	Same as C614	
R601	Res., 7.68M, ±0.5%, 1/8W, Metal	DRE390521
R602	Res., 2.5M, ±0.5%, 1/8W, Metal	DRE390421
R603	Res., 1.25M, ±0.5%, 1/8W, Metal	DRE390431
R604	Res., 750k, ±0.5%, 1/8W, Metal	DRE390441
R605	Res., 250k, ±0.5%, 1/8W, Metal	DRE390451
R606	Res., 249k, ±0.5%, 1/8W, Metal	DRE390461
R607	Res., 120k, ±2%, 1/4W, Metal	DRE134231
R608	Res., 50k, Var., 0.5W, Cermet	DRV410221
R609	Res., 47k, ±1%, 1/4W, Metal	DRE533291
R610	Res., 20k, Var., 0.5W, Cermet	DRV410211
R611	Res., 24k, ±1%, 1/4W, Metal	DRE535821
R612	Res., 10k, Var., 0.5%, Cermet	DRV410201
R613	Res., 11k, ±1%, 1/4W, Metal	DRE535741
R614	Res., 5k, Var., 0.5W, Cermet	DRV410191
R615	Res., 3.9k, ±1%, 1/4W, Metal	DRE535631
R616	Res., 2k, Var., 0.5W, Cermet	DRV410181
R617	Res., 1k, ±1%, 1/4W, Metal	DRE535491
R621	Res., 20k, ±1%, 1/4W, Metal	DRE535801
R622	Res., 20k, Var., 0.2W, Carbon	DRV146091
R624	Res., 1.3k, ±1%, 1/4W, Metal	DRE535521
R626	Same as R604	
R627	Same as R605	
R628	Res., 125k, ±0.5%, 1/8W, Metal	DRE223661
R629	Res., 75k, ±0.5%, 1/8W, Metal	DRE223671
R630	Res., 25k, ±0.5%, 1/8W, Metal	DRE223681

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
R631	Res., 24k, ±0.5%, 1/8W, Metal	DRE223691
R632	Res., 13k, ±1%, 1/4W, Metal	DRE535761
R633	Same as R614	
R634	Same as R615	
R635	Same as R616	
R636	Same as R621	
R637	Same as R616	
R638	Same as R621	
R639	Same as R621	
R640	Same as R617	
R641	Res., 100, ±1%, 1/4W, Metal	DRE535251
R642	Res., 200, ±1%, 1/4W, Metal	DRE535321
R643	Same as R641	
R644	Same as R641	
R645	Same as R642	
R646	Same as R641	
R647	Res., 10k, ±1%, 1/4W, Metal	DRE535731
R648A	Res., (20k,100k), Var., 0.2W, Carbon	DRV146591
R648B	Same as R648A	
D601	Diode, TLR104	DDD070301
D602	Z. Diode, RD6.8EB	DDD032961
D603	Diode, 1S2210	DDD010351
Q601	Transistor, 2SC1815GR	DTR137781
Q602	Transistor, 2SA578	DTR110331
Q603	Same as Q601	
Q604	Same as Q602	
S601	Switch, PS43G(24)4-7-23	DSW035205

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
HORIZONTAL PREAMPLIFIER		
C701	Cap., 0.01μ, +80 to -20%, 50V, Cer.	DCC133571
C703	Cap., 7p, ±0.5p, 50V, Cer.	DCC231101
C704	Cap., 1000p, +80 to -20%, 50V, Cer.	DCC131911
C705	Same as C704	
C710	Cap., 6p, ±0.5p, 50V, Cer.	DCC231001
C711	Cap., 0.047μ, ±10%, 50V, Film	DCF127191
C712	Same as C701	
R705	Res., 5.6k, ±1%, 1/4W, Metal	DRE535671
R706	Res., 3.6k, ±2%, 1/2W, Metal	DRE143861
R707	Res., 2k, ±1%, 1/4W, Metal	DRE535561
R708	Res., 620k, ±1%, 1/4W, Metal	DRE535441
R709	Res., 3.3k, ±10%, 1/4W, Metal	DRE535611
R710	Res., 6.2k, ±1%, 1/4W, Metal	DRE133921
R711	Same as R706	
R712	Same as R707	
R713	Same as R708	
R714	Res., 20k, ±2%, 1/4W, Metal	DRE134041
R715	Res., 270, ±5%, 1/4W, Carbon	DRD134691
R716	Res., 33, ±2%, 1/4W, Metal	DRE133371
R717	Res., 100, Var., 0.5W, Cermet	DRV430541
R718	Res., 750, ±2%, 1/4W, Metal	DRE133701
R719	Res., 470, Var., 0.5W, Cermet	DRV430561
R720	Res., 820, ±2%, 1/4W, Metal	DRE133711
R721	Same as R720	
R722	Same as R719	
R723	Res., 750, ±2%, 1/2W, Metal	DRE143701
R724	Res., 7.5k, ±2%, 1/4W, Metal	DRE133941
R725	Res., 51, ±2%, 1/4W, Metal	DRE133421
R726	Res., 11k, ±2%, 1/4W, Metal	DRE133981
R727	Same as R725	
R728	Same as R714	
R737	Res., 11, ±1%, 1/4W, Metal	DRE535021
R742	Res., 1k, ±1%, 1/4W, Metal	DRE535491
R743	Res., 27k, ±2%, 1/4W, Metal	DRE134071
R744	Same as R743	
R757	Res., 9.1k, ±2%, 1/4W, Metal	DRE133961
R758	Same as R757	
R759	Res., 2.2k, Var., 0.5W, Cermet	DRV430581
D701	Diode, 1S953	DDD010051
D702	Same as D701	
D703	Same as D701	
D704	Same as D701	
D705	Diode, 1S2210	DDD010351
D706	Same as D701	
D723	Same as D701	
D724	Same as D701	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
D725	Same as D701	
D726	Same as D701	
Q701	Transistor, 2SC1815GR	DTR137781
Q702	Same as Q701	
Q703	Transistor, 2SA1015Y	DTR116111
Q704	Same as Q703	
Q705	Same as Q703	
Q706	Same as Q703	
Q708	Same as Q703	
Q709	Same as Q703	
Q710	Same as Q703	
RL701	Relay, HA-112N	DKD062041

DISPLAY CONTROL

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
C702	Cap., 330p, ±10%, 50V, Cer.	DCC234901
C706	Cap., 10μ, ±20%, 35V, Elect.	DCS471301
C707	Same as C706	
C708	Cap., 270p, ±10%, 50V, Cer.	DCC234701
R729	Res., 3k, ±1%, 1/4W, Metal	DRE535601
R730	Same as R729	
R731	Res., 270, ±1%, 1/4W, Metal	DRE535351
R732	Res., 20k, ±2%, 1/4W, Metal	DRE134041
R733	Res., 27k, ±1%, 1/4W, Metal	DRE535831
R734	Same as R733	
R735	Same as R733	
R738	Res., 18k, ±1%, 1/4W, Metal	DRE535791
R760	Res., 9.1k, ±2%, 1/4W, Metal	DRE133961
D708	Diode, 1S953	DDD010051
D709	Same as D708	
D710	Same as D708	
D711	Same as D708	
D712	Same as D708	
D713	Same as D708	
D714	Same as D708	
D715	Same as D708	
D716	Same as D708	
D717	Same as D708	
D718	Same as D708	
D719	Same as D708	
D720	Same as D708	
D721	Same as D708	
D722	Same as D708	
D729	Same as D708	
D730	Same as D708	
IC701	IC, SN74LS00N	DIC140011
IC702	Same as IC701	
IC703	IC, SN74LS04N	DIC140051
IC704	IC, SN74LS74AN	DIC140751
S701	Switch, KSD3-6-10 ILDC	DSW013741

LOGIC CONTROL

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS NO.
C810	Cap., 10μ, ±20%, 35V, Elect.	DCS471301
C910	Same as C810	
R801	Res., 27k, ±1%, 1/4W, Metal	DRE535831
R802	Res., 13k, ±1%, 1/4W, Metal	DRE535761
R803	Same as R801	
R804	Same as R802	
R805	Same as R801	
R806	Same as R801	
R807	Same as R801	
R808	Same as R802	
R809	Res., 4.3k, ±5%, 1/4W, Carbon	DRD134981
R901	Same as R801	
R902	Same as R801	
AR801	Resistor Array, 8-4.7kΩ	DFB016391
AR901	Same as AR801	
D901	Diode, 1S853	DDD010051
IC801	IC, CD4025BE	DIC410241
IC802	Same as IC801	
IC803	IC, CD4069BE	DIC410621
IC804	IC, CD4512BE	DIC414131
IC805	Same as IC804	
IC806	Same as IC804	
IC807	Same as IC804	
IC808	Same as IC804	
IC809	Same as IC804	
IC810	Same as IC804	
IC811	IC, CD4516BE	DIC414061
IC812	IC, CD4011BE	DIC410101
IC901	Same as IC803	
IC902	Same as IC801	
IC903	Same as IC801	
IC904	Same as IC804	
IC905	Same as IC804	
IC906	Same as IC804	
IC907	Same as IC804	
IC908	Same as IC804	
IC909	Same as IC804	
IC910	Same as IC804	

PRINTED CIRCUIT BOARD

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PARTS N
PB100	Control Board	KPN13
PB200	A Sweep Board	KPN13
PB400	B Sweep Board	KPN13

Mead

No. 34710

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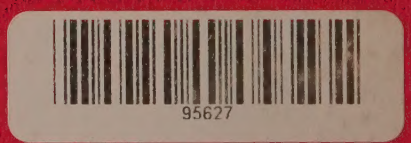
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